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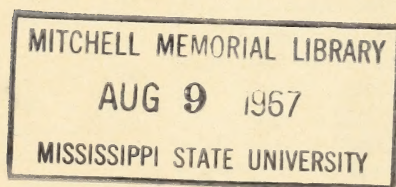


Effects Of Residue Of DSMA In Soils On Cotton, Soybeans And Cereal Crops

By

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EFFECTS OF RESIDUES OF DSMA IN SOILS ON COTTON, SOYBEANS, AND CEREAL CROPS

By E. E. SCHWEIZER¹

Disodium methanearsonate (DSMA) was first used for cotton weed control in Mississippi in 1961. The use of DSMA in Mississippi as a directed postemergence spray to control weeds in cotton has exceeded even the most liberal acreage predictions by weed research scientists.

By 1964, over 329,000 acres of cotton were treated with DSMA as a directed spray. Weed researchers at Stoneville have estimated that about 75% of the total cotton acreage received treatment with DSMA or monosodium acid methanearsonate (MSMA) in 1965. Much of this acreage received multiple treatments.

In the 1930's several research workers in the South reported that high rates of calcium arsenate for boll weevil control resulted in accumulation of toxic arsenate residues in several coarse-textured cotton soils—sands and sandy loams. These workers reported that calcium arsenate in some soils reduced the growth of several plants, including cotton, soybeans, and rice. Other workers reported that residues of calcium arsenate became more toxic to several crops where heavy applications of phosphate fertilizer were applied.

Both DSMA and calcium arsenate are classified as pentavalent arsenicals. DSMA, however, is an organic arsenical, a white solid, water soluble, and has an acute oral LD₅₀ for rats between 700 to 1,000 milligrams per kilogram of body weight. Calcium arsenate is an inorganic arsenical, a white flocculent powder, insoluble in water, and has an acute oral LD₅₀ for rats between 40 to 100 milligrams per kilo-

gram of body weight. The LD₅₀ value denotes the toxicity of a compound. The lower the value, the more toxic the compound. Calcium arsenate would be 10 to 25 times more toxic to rats than DSMA.

Information on the persistence of DSMA in soils and its toxicity to crop plants is meager. Therefore, the present greenhouse study was undertaken to provide preliminary information on the toxicity and persistence of several concentrations of DSMA in soil on cotton and crops generally grown in rotation with cotton; and to investigate possible interactions between phosphorus and DSMA.

Procedure

Three soils—Bosket silt loam, Dubbs silt loam, and Sharkey clay—were used in these experiments. The Dubbs silt loam and Sharkey clay were collected from fallowed fields and the Bosket silt loam from an undisturbed creek bank at Stoneville. Bosket silt loam and Dubbs silt loam were classified as low-phosphorus soils and Sharkey clay as a high-phosphorus soil. DSMA and phosphorus were thoroughly incorporated into small quantities of air-dried soil. DSMA, as 100% disodium methanearsonate hexahydrate, and phosphorus, as $\text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot \text{H}_2\text{O}$, were used in all experiments. We then planted corn, cotton, oat, rice, soybean or wheat seed in this soil. Plant height and fresh weights were taken 4 weeks after planting in all three experiments, except in Experiment 2, where measurements were taken 6 weeks after planting cotton in Dubbs silt loam.

Results

Initial and residual cotton toxicity study.

Experiment 1—The effects of 13 concentrations of DSMA on growth of cotton planted immediately after incorporation of DSMA in Bosket silt loam and at three

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Table 1. Initial and residual toxicity to cotton from incorporating thirteen concentrations of DSMA in Bosket silt loam (Experiment 1).

DSMA ppmw	Percentage height inhibition ¹			
	Initial	16 weeks ²	24 weeks ³	32 weeks ⁴
2.5	0a	0a	—	—
5	0a	2a	—	—
10	0a	6a	—	—
20	0a	4a	—	—
30	0a	4a	—	—
40	0a	6a	—	—
60	8a	12ab	—	—
80	23b	13ab	6a	4a
120	91c	23b	3a	3a
160	100c	26b	5a	15b
240	98c	48c	21b	22b
320	100c	52c	36c	39c
480	100c	76d	65d	60d

¹Means compared by Duncan's Multiple Range Test at the .05 probability level. Any two means followed by the same letter do not differ significantly.

²Replanted 16 weeks after incorporation of DSMA.

³Replanted 24 weeks after incorporation of DSMA.

⁴Replanted 32 weeks after incorporation of DSMA.

replanting dates are shown in Table 1. Replanting dates refer to the number of weeks elapsed between the initial planting and the next recropping.

In the initial planting, the growth of cotton was significantly inhibited in soil containing 80 parts per million by weight (ppmw) or more of DSMA. (One ppmw is equivalent to about 2 lb/A.) Concentrations of 60 ppmw or less, however, had little or no effect on growth.

When the soil treated with these same 13 concentrations was recropped 16 weeks after the initial application of DSMA to the soil, the growth of cotton was significantly inhibited in soil which had been treated initially with 120 ppmw or more of DSMA.

Growth of cotton was affected similarly by soil concentrations of DSMA at the 24- and 32-week replanting dates. Growth of cotton was also affected less from residues of DSMA in soil at the 24- and 32-week replanting dates than at the 16-week replanting date.

The most marked reduction in toxicity of residues of DSMA in soil occurred between the initial planting and the 16-week

replanting date. The detoxification of residues of DSMA in soil between 16 and 32 weeks was of much smaller magnitude.

Phosphorus-DSMA cotton study. Experiment 2—Two greenhouse experiments were conducted to determine if the application of additional phosphorus to soil would increase the toxicity of DSMA. The effect of phosphorus fertilization and DSMA concentration on 4-week old cotton grown in Bosket silt loam is shown in Figures 1 and 2.

The top row in Figure 1 shows that added phosphorus increased cotton growth in the absence of DSMA. The bottom row shows the interaction between 100 ppmw of DSMA and five concentrations of phosphorus. Note that DSMA injured cotton more as the concentration of phosphorus increased.

In Figure 2, the top row shows that DSMA injured cotton more as the concentration of DSMA was increased from 0 to 100 ppmw in soil containing 320 ppmw of phosphorus. The bottom row shows the effect of four concentrations of DSMA on cotton in the absence of ap-

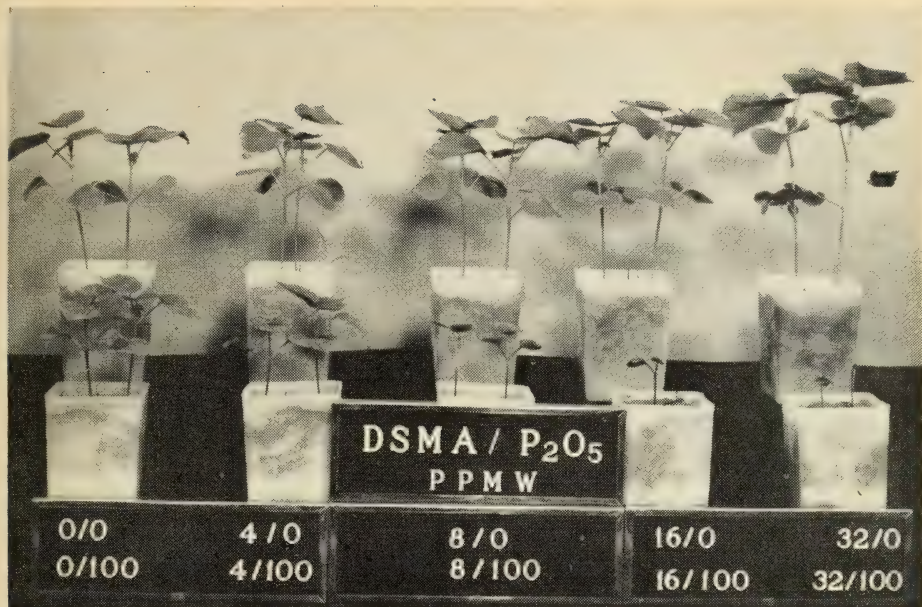


Figure 1. Effect of incorporating five concentrations of phosphorus and 100 ppmw of DSMA in Bosket silt loam on 4-week-old cotton. Phosphorus rates appear first and DSMA rates second. Phosphorus rates were 10 times higher than shown here. For example, 32/100 refers to 320 ppmw of phosphorus plus 100 ppmw of DSMA applied to the same container.

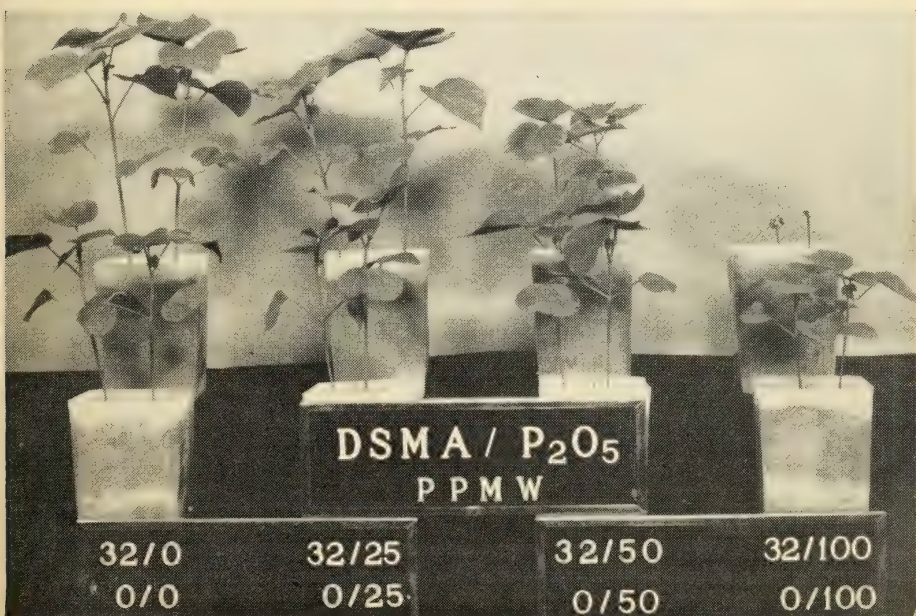


Figure 2. Effect of incorporating four concentrations of DSMA and 320 ppmw of phosphorus in Bosket silt loam on 4-week-old cotton. Phosphorus rates appear first and DSMA rates second. Phosphorus rates were 10 times higher than shown here. For example, 32/100 refers to 320 ppmw of phosphorus plus 100 ppmw of DSMA applied to the same container.

plied phosphorus.

In both soils, added phosphorus increased the detrimental effect of DSMA on cotton, particularly in the low-phosphorus Bosket silt loam. However, in Dubbs silt loam, inhibition was only 12% from the combination of 120 ppmw of DSMA and 320 ppmw of phosphorus as compared to 56% in Bosket silt loam soil from the combination of 100 ppmw of DSMA and 320 ppmw of phosphorus.

Toxicity of DSMA to cotton and other crops. Experiment 3—The effect of 50 ppmw of DSMA on corn, oats, rice, soybeans, and wheat when incorporated in Bosket silt loam was also studied. Rice was the most susceptible crop to DSMA and wheat was the most tolerant. Growth of rice in treated soil was inhibited 75%. Comparative values for other crops were: soybeans 39%, oats 12%, corn and cotton 10%, and wheat 0%.

Because the growth of rice was severely affected in Experiment 3, three additional experiments were conducted to

determine the concentration of DSMA that rice would tolerate in Bosket silt loam, Dubbs silt loam, and Sharkey clay soil. DSMA, incorporated in the soil at concentrations up to 100 ppmw, affected the growth of rice only in Bosket silt loam. The growth of rice was significantly inhibited in Bosket silt loam after 4 weeks at concentrations of 5 ppmw or more. However, after 12 weeks, no toxic residues of DSMA from initial applications as high as 50 ppmw were detected. Rice was not affected in Dubbs silt loam or Sharkey clay after 4 weeks.

Rice tolerance to DSMA when soil-incorporated in Bosket silt loam and Sharkey clay is shown pictorially in Figures 3 and 4.

Discussion

The data obtained from these greenhouse experiments indicate the need for critical field experiments to determine whether the continuous application of DSMA to control weeds in cotton will result in residues toxic to cotton and crops

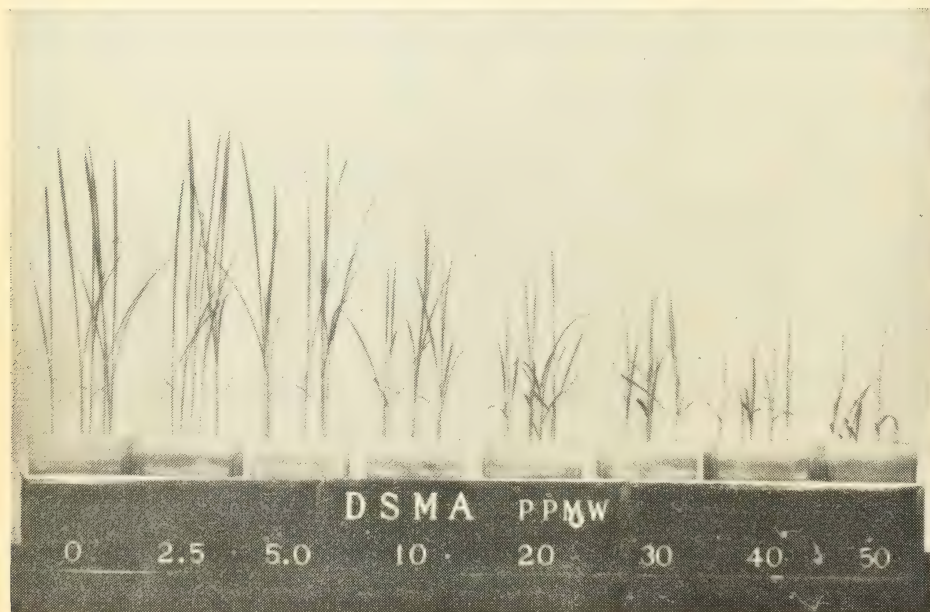


Figure 3. Rice tolerance to DSMA when incorporated in Bosket silt loam soil. Rice was 4 weeks old when photographed (first crop).



Figure 4. Rice tolerance to DSMA incorporated in Sharkey clay. Rice was 4 weeks old when photographed.

grown in rotation with cotton. Several specific field problems that should be studied are: maximum amount of residues of DSMA in soil that cotton can tolerate; maximum amount of residues of DSMA in soil that other crops in a cotton rotation can tolerate; effect of accumulation of residues of DSMA on crops grown in soils that have a low clay but a high phosphorus content; fate of DSMA in soil; adsorption of DSMA to soil colloids; and effect of past treatments of calcium arsenate on the toxic threshold level of residues of DSMA in soil.

Let's take a closer look at the first three specific field problems enumerated above. Will the continuous application of DSMA to our soils create an immediate problem? Although field data on the residual toxicity of DSMA in soil are limited, a brief discussion will follow on what we know from research conducted in the greenhouse and field.

What level of residues of DSMA in soil will cotton tolerate under field conditions. A specific level is not known.

However, a maximum application of 2.4 lb of DSMA per year on a 16-inch band (equivalent to 6 lb/A per year on the area actually treated) is currently recommended in Mississippi for postemergence weed control in cotton. In our greenhouse work, cotton tolerated 60 ppmw or about the equivalent of 120 lb/A of DSMA in the soil.

If 120 lb/A of DSMA in the soil is the critical level under field conditions, more than 50 years would elapse before residues of DSMA from recommended band treatments would reach levels toxic to cotton. This example assumes that residues of DSMA in soil are not dissipated in any manner, and that soil treated in the band each year is mixed with untreated soil the following season. If broadcast treatments are used, the rate of accumulation might be $2\frac{1}{2}$ times more rapid than that from band treatments.

We have collected soil samples for 2 years from two cotton fields at Stoneville. The soil samples were taken in October after cotton was harvested. Each field

was treated twice with the recommended postemergence band rate of DSMA (2.4 lb of DSMA on a 16-inch band or a total of 6 lb/A on the area actually treated). These samples were bioassayed in the greenhouse for residues of DSMA. Neither oat or soybean growth was affected when harvested 4 weeks after planting.

What crops grown in rotation with cotton are most likely to be injured from residues of DSMA in soil? Our results from the greenhouse experiments showed that rice was the most susceptible crop to residues of DSMA in soil. However, rice was injured only in Bosket silt loam and not in Sharkey clay. Most of the rice in Mississippi is grown on the heavier soil types. Residues from currently recommended usage of DSMA on 16-inch bands in cotton on these heavier soils should not reach levels toxic to rice in less than 80 years, unless the effect on growth is not indicative of total effect. On Bosket silt loam, however, it appears that DSMA could reach levels toxic to rice within 3 to 6 years.

The maximum amount of residues of DSMA in soil that rice will tolerate under field conditions should be determined. Rice following cotton treated previously with calcium arsenate, when injured, produced either very low yields or blighted completely.² Straw yield and quality were not affected but rice heads were empty and unfit for milling. It is not known whether residues of DSMA in soil will produce similar effects.

Another concern is the effect of residues of DSMA in soil on crops grown in soils with a low clay but a high phosphorus content. In our greenhouse experiments, cotton was severely injured in Bosket silt loam and slightly injured in Dubbs silt loam when increments of both phosphorus and DSMA were added. The main differences between these two soils were: pH and the amounts of calcium, clay, phosphorus and potassium. Dubbs silt

loam had a pH of 6.4 and Bosket silt loam 7.9. Dubbs silt loam contained 1 3/4 times more calcium, 5 1/2 times more clay, and 2 1/2 times more phosphorus and potassium than Bosket silt loam. Pronounced injury to some crop plants has occurred where heavy applications of superphosphate were applied to soils, low in clay content, which had previously received calcium arsenate. I believe that crop injury from residues of DSMA under field conditions would be more likely to occur in soils, low in clay content, which receive a heavy application of phosphate fertilizer.

In the November, 1965, issue of Mississippi Farm Research, Dr. Joe Pettiet presented a summarization of soil test data from 10 Mississippi Delta counties. Of the 704 soil samples collected from 352 sites, 4% of the topsoil samples collected from the 0 to 6-inch depth and 14% of the subsoil samples collected from the 6 to 12-inch depth were low in available phosphorus. Furthermore, the lowest levels of available phosphorus were found in samples of the sandy loam and silt loam soil groups. These two soil groups also contained the lowest percentage of clay. If residues of DSMA in soil were to accumulate, crop injury might occur in either one of the latter two soil groups following a heavy application of phosphate fertilizer.

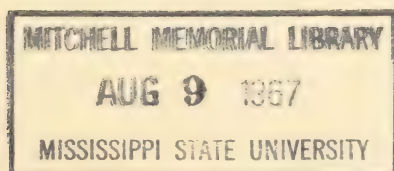
This discussion should point out several areas where crop injury might occur if residues of DSMA in soil were to accumulate. It will take several years before definite answers can be obtained to the specific field problems outlined above. Therefore, each farmer should report any suspected crop injury from residues of DSMA in his soils to his local county extension agent.

ACKNOWLEDGMENTS

The National Cotton Council, through its Foundation for Cotton Research and Education, supported this research. The Ansul Chemical Company supplied the DSMA. Dr. J. V. Pettiet gave valuable assistance in determining the physical properties of these soils.

²Reed, J. F. and M. B. Sturgis. 1936. Toxicity from arsenic compounds to rice on flooded soil. Amer. Soc. Agron. Jour. 28: 432-436.

The Imported Fire Ant in Mississippi



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ON THE COVER:

The photograph on the cover shows an unusually large imported fire ant mound in northeast Mississippi. This picture and the other two used in this bulletin were furnished by Dr. Ross E. Hutchins.

PREFACE

The imported fire ant presents many challenges to mankind. We can only hope that our social structures may ever be so orderly. The plastic responses of this species to its environment allows it to be highly successful and adaptable. This is of course, scant comfort to those people in infested areas.

The imported fire ant in its various phases may be: fragile or rugged, innocuous or fierce, secretive or obvious, subterranean or arboreal, terrestrial or aerial, solitary or gregarious, and so on **ad infinitum**. It seems neither to truly hibernate or estivate, yet it survives. It is omnivorous and voracious yet it may fast. It may survive drought or flood, fire or upheaval.

It is hoped that the information presented here may serve as both an introduction to those needing to learn about the imported fire ant, and as an informal review for those who may desire to see the relationship of the many facets of the subject presented in other published works.

THE IMPORTED FIRE ANT IN THE SOUTHEASTERN UNITED STATES

By

H. B. GREEN

The imported fire ant has been the subject of many popular articles, some of them sensational, in the past decade. The same ant has been discussed frequently in technical papers where it is known as *Solenopsis saevissima* (F. Smith) broad sense. Few insects can arouse the interest of the layman or the scientist as this one, yet its presence would go largely unheeded, but for the vicious stings and the building of large mounds.

When a mound of the imported fire ant is disturbed, the ants rush out and climb up any foreign object. When they find a suitable place to sting, they bite with their mandibles to hold more securely and perhaps puncture the skin. Then they turn the sting on the tip of their abdomen to the wound and inject venom. A very few people have shown violent reactions to stings of the imported fire ant, but these individuals represent a very small fraction of our population. Most people feel a violent burning sensation from the stings, and in some cases a necrosis in the area of the sting occurs and a small sterile pustule forms on the skin. People in areas infested by the imported fire ant soon become wary of their mounds.

The mounds made by this ant are most noticeable in late winter and in the spring

of the year. The mounds vary in size with: the age of the colony, habitat, season of the year, and some other factors that will be discussed later. They are most frequently seen in pastures or other areas where the grass is short, but the ants have been known to live in almost any situation from sandy beaches to the heaviest of clay soils. One major complaint by farmers concerning the fire ant, is the damage to mowers and other farm machinery when the mounds, which are often reinforced with grass, are struck by the machines. Populations of this insect may be a nuisance during harvest of many crops and there are records of some damage to crops, particularly vegetables.

Imported fire ants have seldom been reported to be detrimental in their feeding. The chief food is other insects, or insect products, such as honeydew of aphids or mealybugs, but the extent of their beneficial effect in this manner is not known.

Generally property owners are strongly opposed to the presence of the imported fire ants and because of spread of this pest to wide areas, federal work is being directed toward containment of the infestation with the intent of their eventual eradication from the United States.

IMPORTATION (S)

The imported fire ant, *Solenopsis saevissima* variety *richterii* Forel, was first reported in the United States at the port of Mobile, Alabama. The exact time, manner and source of this importation will probably never be known. The first official recognition of the imported fire ant was made by H. P. Loding in an observation dated July 15, 1929, in the

U.S.D.A. Insect Pest Survey Bulletin 9. The species was included by W. S. Creighton in 1930 in a paper entitled "The New World Species of the Genus *Solenopsis*." Creighton reported that he first saw these ants in urban Mobile in 1926. He stated that he was told by Mr. Loding that they had appeared on the Mobile Bayfront in 1918.

The author observed the imported fire ant to be widely spread in urban Mobile in 1924. The imported fire ants in Mobile at that time were a dark brown color similar to those now found in the northeast Mississippi infestation. Highly effective insecticides were not available then, and there was no serious concern by most people that it would ever be accorded much national attention as a pest. Other native species of the same genus were well known then and they were usually not a serious pest, so even the larger mounds and more painful stings of the imported fire ant caused no great concern at that time.

There was apparently a slow spread of the imported fire ants for a number of years. Following World War II several highly effective insecticides such as chlordane became available and some control and eradication work was begun in several places. At first it appeared that individual mound treatment with the new insecticides would give almost complete kill of the ants; but in several years it became evident that natural reinfestation of the treated areas nullified the efforts.

At the time this early eradication work was going on in Mississippi, there were some widely isolated infestations of the imported fire ants, where this type of work might avoid their further spread. These isolated infestations appeared to have resulted from the ants being carried many miles into uninfested areas.

There are several known methods of spread of the imported fire ant. (1) Mechanical transportation of all or much of an intact colony from one place to another may occur. (2) Floodwater floating of colonies from inundated mounds will spread them for miles downstream. (3) Flights of mated queens will spread the ants under normal conditions several miles each generation—(the exact flight limitation of a mated queen is unknown). Again mechanical transportation can oc-

cur, by a mated queen being carried to a new location. (4) Colonies of ants frequently move by walking to new mound locations.

Under conditions of food scarcity, colony population pressure, or physical mound disturbance, colonies have been known to move as much as several hundred feet.

It was mentioned earlier that the first imported fire ants encountered in the United States were dark brown. The queens of these ants and their larger workers, which are imperfect females, have a honey colored band across the abdomen or gaster. Sometime after 1930 it was noted that some lighter colored fire ants were along the Gulf Coast, and by 1950 most of the ants along this area of both Mississippi and Alabama were the lighter type.

At this time there was a small group of entomologists employed by the USDA, BEPQ, Division of Insects Affecting Man and Animals, stationed at Mobile, Alabama to make some studies of biology and control of the imported fire ant. Mr. Leyburn F. Lewis of this group, in a quarterly report, made some interesting observations concerning the variety of colors of these ants in the Mobile area. He found that in very wet, marshy situations, they were of the brown type or phase, while in the surrounding better drained areas, all the imported fire ants were the light colored phases. (The term "light colored" has been used here concerning the imported fire ant to cover a number of combinations of red, light brown, tan, or yellowish colors that may be found.) The author spent a day with Mr. Lewis at that time visiting a variety of ecological situations to study the relationship of soil moisture and fire ant colors. It appeared that the dark colored phase was being replaced by the lighter colored phases, and the reason for the presence of the dark ants in the very wet situations was that they had not been replaced due to the isolation of



In relatively recent years the imported fire ant has spread over this section of the Southeast. (Infestation as reported by USDA ARS Plant Pest Control Division, Southern Region.)

their colonies.

Wilson and Brown (1958) stated that the light phase of *S. saevissima* in the United States is morphologically identical to a geographic variant from a central sector of the South American mother population which has a large range there. Further they stated that the light phase interbreeding with the dark phase in the United States has resulted in a graded series of intermediate color forms, suggesting that the two extreme forms differ by polygenes. They inferred that until this interbreeding came about, that there was little spread of the ant in the United States, since the dark phase was not as successful or aggressive as the light phase. These writers seemed convinced that a second importation of the fire ant from South America occurred when the light phase ants appeared in the United States.

It would seem, however, that since both phases of *S. saevissima* were present in South America, that the light phase would have supplanted the dark phase

there; or that interbreeding would have taken place to produce intermediate color forms like those found in the United States. Further it could be pointed out that the dark phase has spread rapidly in the United States since its removal from the Mobile area. Thus it can be said that the rapid spread of the imported fire ant in the United States did not necessarily depend on the introduction of the light phase as was inferred by Wilson and Brown (1958).

This then would pose the question of why the spread of *S. saevissima* was so slow for a number of years, and then spread so rapidly. Perhaps some sociological changes in the human population had much to do with it as will be explained later. The spread of the imported fire ant has been slowly progressing northward from a wide base along the Gulf Coast area of Texas, Louisiana, Mississippi, Alabama, and Florida. The spread to the north has been greatly accelerated in Mississippi, and perhaps in other places, by population skips dur-

probably to human movement of the ants. This amounted to approximately 230 miles from the coast in the case of the dark phase infestation at Artesia, Mississippi. The spread to the north by natural means of queen flights has been aided by the prevailing winds from the south at the time of the greatest queen flights in the spring and early summer.

The spread to the east and west of Mobile for hundreds of miles along the Gulf Coast can best be explained by human movement of the light phase ants. This can best be illustrated with a map (Figure 1). Culpepper (1953) reported the movement of the imported fire ant by the shipment of nursery plants from infested areas. There are several plants such as azalea and camellia for which Mobile is famous, and there are a number of nurseries in that area from which plants have been moved along the Coast. Since most of the movement of these plants, and the widespread development of the Gulf Coast areas occurred subsequent to the transformation of most of the fire ant population of the Mobile area to the light phase; it seems likely that their movement east and west might have occurred largely by shipment of nursery plants. These plants are usually moved with a sizeable ball of soil around the roots, thus colonies of ants could easily be transported in the soil moved with the plants. Azalea and camellia are not cold hardy and do best along the Gulf Coast, thus the ant movements to the north in this manner likely would have been slow.

A human sociological aspect of the problem may have been involved in the slow spread of the dark phase ants northward from the Mobile area before the advent of the light phase ants in that area. Prior to the decade of the 1930's, the "cut-over pine lands" along the Gulf Coast area of Alabama and Mississippi were annually "burned over." Tenants and squatters in this area, and even some landowners, favored the prac-

tice of setting fires in the winter to burn the grass residue of the previous year. It was claimed that this practice favored early cattle and sheep grazing in the spring; but probably the tenants and squatters knew it also killed pine seedlings, that would force them from the land. The heat of the grass fires might easily have killed small new colonies which would have been near the soil surface at this time of the year, and survivors would have been faced with a dearth of food.

It was pointed out by Wilson and Brown (1958) that the light and dark phase imported fire ants differ in several ways other than color, such as: total size, size and form of the nest, and certain habitat selections. It is easily seen that the light phase ants build smaller mounds in most locations, and that the number of mounds per acre is much greater in the light phase ant population in Mississippi. From experience with a number of counts of mounds made in connection with control experiments with rather stable populations, it can be said that the dark phase ants in the Artesia, Mississippi area seldom exceed 20 mounds per acre, while the light phase ants north of Gulfport, Mississippi frequently exceed 30 mounds per acre, or about 50 percent more.

The light phase ants produce some brood during each month of the year in the southern part of Mississippi. This winter brood production is also reported from other states. By contrast, the dark phase ants stop brood production in the Artesia area usually in early December. Cold does not seem to be the controlling factor in this matter, since it usually gets colder in the southern part of the state during January than it does in Artesia in early December. The mean December temperature near Artesia from 1931 to 1960 was about 47°F., while the mean January temperature from 1931 to 1960 was 46°F., near Artesia, and 49°

F. in the southern part of Mississippi, where the light phase ants are found. Mean temperatures do not indicate the low extremes certainly, but soil temperatures where the ants are, do not fluctuate as much as free air temperatures.

Certain of the differences of dark and light phases might well be considered in the control or eradication work with the imported fire ant. The mounds of the dark phase ants are easier to see because they are larger than the mounds of the light phase ants. Individual mound treatment of the smaller, more numerous light phase ant mounds makes their control by this method less effective, since it depends upon finding the mounds. Also, the extended brood production of the light phase ants may pose a threat of reinfestation of treated areas by their queens earlier in the year. This point

has not been proven, but there seems to be a possibility that this could happen.

The United States species of the genus *Solenopsis* were reported on by Snelling (1963). In this work the true fire ants are placed in the subgenus *Solenopsis*. The imported fire ant in the United States was referred to as *S. saevissima* (F. Smith), broad sense, rather than *S. saevissima* variety *richterii* Forel, which refers only to the dark phase. This conclusion was drawn as a result of the observations reported by Wilson (1952) and Wilson and Brown (1958).

If indeed the light phase ants eventually replace the dark ants on the hundreds of square miles they now infest, this position may result in less complicated reference to the species in general, to call them *Solenopsis saevissima* (F. Smith), broad sense.

LIFE HISTORY

A new colony of the imported fire ant starts with a mated queen, thus her source must be considered first. The queens have wings and may be produced by the hundreds in large mounds. At the same time an even greater number of winged males are usually produced. Some colonies may produce nearly all one sex or the other, and in the fall of the year, many colonies appear to produce only males. The winged queens and males are of nearly equal size, but the males can be easily distinguished by their very small heads (pinhead size), and their large humped thorax where the wings attach.

Some of the winged forms may be found in the mounds in any month of the year, and mating flights have been observed in all months: but in spring, mounds of all sizes makes great efforts to produce the winged forms in large numbers for flights in the late spring or early summer.

Mating or nuptial flights have frequently been seen during the middle of the

day when it was bright and sunny, with a temperature of about 70°F. or higher. It is not known what causes or triggers these flights; but it seems to be related to a period of unsettled weather which usually results in rain just before or after the flight. Since these flights have been known to take place over an area of many hundreds of square miles on the same day, it is suspected that barometric pressure variations may be involved. This is the only weather variable that would be nearly the same over such a large area. This position is further strengthened by the fact that the winged or alate reproductive forms from indoor captive colonies fly at the same time as those under natural conditions. This is true even though the indoor conditions of temperature and humidity are very different from outdoors, and very little day-to-day variation is possible.

On the day that nuptial flight occurs, the worker ants become very agitated or excited in the area of the mound. Shortly before the flights, the workers

tear several holes about an inch in diameter in the top crust of each of the mounds from which flights are to occur. The alate reproductive forms issue from the mounds through these holes and climb up grass or other objects nearby, and from these they fly almost straight upward. It was reported by Wheeler (1960) that many kinds of ants mate high in the air in swarms. This has mostly been observed in Europe, but it is also known to occur in this country. There have been some studies of this aspect of the biology of the imported fire ant in Louisiana by Dr. Murray Blum of Louisiana State University, but this work is as yet unpublished.

On several occasions, large numbers of mated imported fire ant queens have been found descending from their nuptial flights on a small area about 100 feet in diameter. In these small areas thousands of the queens have been collected for starting study colonies; however, very few males were observed. At other times, the bodies of vast numbers of males have been found in small areas following nuptial flights and this may be further evidence that mating occurs in swarms. Males live only a short time after they leave the mound, though some may live in the mounds all winter with worker ants to tend them. Thus it seems they have very limited body reserves.

Although it would appear from the above discussion that the queens descend from the nuptial flights come down in small areas at high concentrations, there is also good evidence that they scatter over wide areas. This can be seen easily in the almost uniform distribution of mounds over vast areas of infested lands.

Queens, unlike the males, have great body reserves of nutrients when they leave the mound, for they are able to lay eggs and rear a small group of tiny worker ants from regurgitated, reabsorb-

ed tissues of their bodies. This has been observed in the laboratory many times where the queens were confined individually in glass vials without food or free water. Their only requirement seems to be a high relative humidity (near the saturation point).

When the queens alight after their nuptial flights, they chew away their wings and walk about for a few minutes, usually until they find a nest site to their liking in which to dig a small hole or burrow. The burrow made by a queen is usually about two inches long. Most of them that have been dug out, went down about one-half inch and then turned to go parallel with the surface of the soil, terminating with a slight enlargement or chamber.

If for some reason (such as too hard soil) the queens do not get their chambers started in several hours, they may concentrate in large masses under objects on the soil surface such as boards. This fraternizing is contrary to the traits expressed by workers in the colonies, who defend their area of domination around their mounds against any intruders.

It was reported from laboratory studies by Khan (1965) that within 48 hours after their nuptial flights, nearly 100 percent of the queens started laying a few eggs. They were very maternal toward their first young. When they were disturbed they picked up in their mandibles and carried their mass of brood which they had stuck together with a protective mantle of saliva. Usually, the eggs hatched after several days and the queens fed the young larvae, as was mentioned earlier, with regurgitated, reabsorbed body tissues. Their useless wing muscles contain good source of this food material. The imported fire ants have a complete metamorphosis in their development and following the helpless globe-shaped larval stage, there is a pupal stage in which the characteristic ant structures



Inside the fire ant mounds are thousands of worker ants of various sizes. Here are shown workers caring for the young ants.

form, and can actually be seen before the ants become active adults.

The first workers reared by their queen are tiny. The workers of this caste are usually referred to as the minim workers. As more and more of these tiny forms mature, they begin to forage a short distance for food in about the fifth week following the nuptial flight of their mother. At this time there may be about 10 to 20 of them, and in addition to their food gatherings, they assume the responsibilities of caring for the eggs and brood of the colony. In nature the queens have been seen to leave their burrows and travel a short distance in the early stages of colony development. It is not known if they forage for food, but it seems unlikely, since workers always feed them in the colony.

In the laboratory, it was necessary to

completely isolate the colonies when the minim workers became active, or they would abscond with the brood of their colony and move to join forces with the progeny of another queen, (Khan 1965). When several such colonies joined, they constituted a much more powerful force. It is not known if this happens in nature, but if it does occur, it would help the chances of survival of some of the colonies.

It has been found that frequent summer shower activity greatly enhances the chances of survival of the small new colonies by increasing the surface soil moisture, as was shown by Green (1962), who reported that as many as 1000 of the small colonies per acre had been counted. Earlier, (1952) Green reported that by midwinter only about 10 percent of the number of such small new colo-

nies could be located. It is not known if many of them joined forces during bad weather, or if large numbers died out.

As the minim workers of a new colony increase in number, and the food they can supply by foraging increase, the size of the workers produced in the colony gradually increases. Eventually the larger sized workers reach a size or caste arbitrarily called minor workers, and later on a larger media caste, and still later the largest or the major caste. It was mentioned earlier that the major caste workers have a band of color on the abdomen or gaster like queens. In the spring, almost a year following the nuptial flights of their queens, new colonies have been found to produce alate or winged reproductive forms; and thus this completes the reproductive cycle of

the imported fire ant colonies. It has been reported informally by other workers with the imported fire ants, that they believe that they have seen some small new colonies that have been able to produce alate brood in the same summer or fall of the year that the colony started. This would possibly be of importance in timing retreatment activities in an eradication program.

Colonies reared in the laboratory from mated queens collected in the summer produced alate reproductive forms the following spring at the same season that the wild colonies in the field did so, at State College, Mississippi. This is in the same area with the dark phase ants from the Artesia infestation, where the alate brood production starts usually about the first of March.

WEATHER EFFECT ON NEW COLONY SURVIVAL

The spread of the imported fire ant has been restricted to some extent by dry weather in the summers. The most impressive example of how good weather conditions may influence the spread of the fire ant can be seen in the so-called "explosive" infestation of mounds that became noticeable about January 1957. These mounds resulted from high colony survival as influenced by the frequent summer showers of 1955 in the southeastern states. These showers started in most places in mid-June and lasted until about mid-August. More important than the amount of rainfall, was the number of showers and their frequency. The relation of summer shower activity to fire ant colony establishment from 1946 to 1960 was reported by Green (1962). In this period the shower activity was favorable for new colony survival only in 1946, 1949, 1950, 1955, and 1958 and each of these seasons resulted in a high rate of survival. The 1949 and 1950 groups, however, were probably killed by sub-zero weather in the early part of 1951 when

the colonies were quite small.

The effect of extreme cold on imported fire ant colonies was reported by Green (1959). Under proper conditions, cold does not seem to seriously affect most of the ant colonies. Many large mounds may have little or no mortality in sub-zero weather. This seems to be due to the warming effect of the soil and the insulation of the air spaces in the larger mound.

When the ants get cold, they stop moving. This usually happens a few degrees above freezing of the air temperature, when the ants stop and can be found motionless in various parts of the mound. They do not "ball" like honeybees, but may lie motionless for days until the weather is warm again. During this time of cold inactivity, the ants are helpless. When they are warmed slightly, even by holding them cupped in the hand, they will immediately resume activity.

It was found by Khan (1965) that ants were killed by a 24-hour exposure to

soil temperatures to 6 to 8°F. Also, it was found that when ants were held at a soil temperature of 32°F. for 7 days, about 70 percent of them died.

It was reported by Green (1959) that cold, under certain conditions in Mississippi, in 1958 had resulted in heavy ant mortality. The conditions that resulted in mortality were: that the ants in newly constructed mounds that had no grass for reinforcement in them, and had frost heaving of the soft soil, were settled in a cold rain, which was followed by several days of severe cold (between 10

and 20°F.). This mortality resulted apparently in the portions of the mounds that settled, and thus lost their effect of insulation. The cold mortality in this case was an unusual combination of weather conditions. Usually rains occur at temperatures that are high enough for the ants to repair the mounds before the cold that follows. It appears, however, that in the United States, cold weather may be a limiting factor in the northward progress of new colonies, while the westward progress may be hindered by dry weather in the summer.

MOUNDS

The mounds of the imported fire ant are their most noticeable single characteristic. Although other ants build mounds, no other in the southeastern states build in such a spectacular manner as this ant. It was mentioned earlier that the mounds of the dark phase ants are larger than those of the light phases. The mound may be considered the focal point of the colony, as all activities radiate from or to this point.

The mounds are used in two ways: first to achieve a gradient of temperature and humidity best suited to the brood; and secondly, to evade excessive water or local flooding. Thus in dry, hot weather, they are not maintained to a high peak; and in very wet weather, particularly in the summer when there is much brood, they may be constructed very high. The latter is particularly true in a shade of tall grass away from direct sunlight.

The most noticeable mound construction occurs about mid-winter when the ants seem to anticipate the big spring brood production. This large mound building often occurs, in the case of the northeast Mississippi dark phase ants, about six weeks before the first eggs are laid. When the spring brood is start-

ed, the first few eggs can easily be detected by removing the mound crust on the sunny side. Since the weather is often cool at this season, the brood in the mounds is shifted during the day from the east to the south, and finally to the west side, in order to keep the brood on the sunny side of the mound. If the heat of the sun on the mound is too great, the brood is shifted to a cooler spot away from the sunny side. Vertical movement of the brood in the mound allows the ants to select the optimum humidity for brood development.

In very hot dry weather the ants move the brood below the soil line, under the mound proper. This is done to find the proper conditions for the brood development. The below-ground galleries are usually about equal in extent to those above ground. The underground galleries form a cone shape below the mound then there are several more or less twining vertical diggings that go much deeper. The extent of these deep diggings is unknown below the level of four feet; but perhaps they may go to a level of free soil water.



Typical fire ant mound.

The mounds each have several foraging tunnels radiating from them about one-half inch below the soil level. Usually there are five or six such tunnels leaving the mounds at more or less fixed positions. The extremities of the tunnels are temporary, and can be changed easily as the needs arise. The tunnels branch and rebranch to fan out over the foraging area. They are constructed by moving soil particles from a new foraging run the ants start on the surface of the soil. These soil particles are placed along the sides of the run and eventually they bridge over the top and the tunnel is then underground. Thus they may simultaneously dig the whole length of the tunnel and quickly finish it. Tunnels may have holes that lead to the soil surface, or they sometimes terminate with a hole to the surface to allow the foraging ants access to the mound. Frequently tunnels lead to the base of plants where the ants are feeding. This will be discussed later concerning feeding habits.

During periods of frequent showers or rains, the ants use soft soil particles almost exclusively to build or repair the mounds or tunnels, but during dry, hot weather this is almost impossible, and under these conditions, various plant parts or ground litter may be employed. In a few cases the ants have been seen using green leaf or stem fragments apparently cut from plants solely for this purpose. During dry weather the ants have been seen to take advantage of natural soil cracks to construct tunnels. This was done by covering the cracks with bits of plants or particles of litter.

As was mentioned earlier, a growth of grass or weeds frequently comes up through the soil in the mounds. This seems to aid in reinforcing the mound structure and the ants do not usually try to remove it. This is particularly useful to them during the winter rains when some unreinforced mounds tend to settle due to heavy wet soil, at a time when the ants are too cold to make repairs. In general, the mounds do not deteriorate

badly from rain or weathering. This is apparently due to a bonding or waterproofing substance the ants use with the soil as the mounds are constructed. The surface of galleries have a waxy feeling to the touch, and the mounds will withstand complete inundation with little apparent ill effects.

The galleries of a mound and those in the soil below it are arranged as a random labyrinth of interconnected tunnels about one-fourth inch in diameter. The junctions of the soil structures are faired or shaped to offer a buttress effect in all directions.

The imported fire ants frequently build their mounds around, next to, or on some object such as a tree stump. They also move to fence rows, pond dams, ter-

aces, ditch banks or other elevated areas. These actions all seem to be related to getting out of overly wet soil conditions. Slopes such as road fills are favorite sites for mounds. The ants tend to take advantage of any higher soil area to get a gradient of soil moisture conditions for their brood rearing.

Some observers have stated that the ants will move from areas, such as plowed fields, where mounds are frequently disturbed. This point has never been proven, and cases can be cited where the mounds have been disturbed daily without causing the ants to move. Possibly the moves that occurred following the plowing of fields may have been due to a dearth of food in the area after it was clean plowed.

ECOLOGY

It was mentioned earlier that the light phase ants were replacing those of the dark phase. In a similar manner either the dark phase or the light phase have been replacing the southern fire ant, *S. xyloni* McCook, where the two species have met in Mississippi. This was also reported by Wilson and Brown (1958), but they reported that this is not entirely the case with *S. giminata* (Fabricus), the tropical fire ant, in locations where it occurs. This seemed to be due to a dark phase of the latter ant species surviving in woodland sites where the imported fire ant is usually less numerous.

The low numbers of the imported fire ants in hardwood forest was reported by Green (1952). It was noted also by Green (1962) that tall grass or other heavy growths of vegetation restricted the establishment of new colonies. This seems to be due to the removal of surface soil moisture by plants in the summer when it is needed by the queens to rear their first brood in their shallow burrows. If a colony becomes established in such a wooded location, the ants seem to fare quite well, and they have

been found to forage in the tops of timber by climbing the boles or trunks of the trees. The light phase ants frequently have large populations of colonies in young pine timber along the southern part of the range near the Gulf Coast. The rainfall in this area is usually frequent, and this may account in part for the success of new colony establishment in the pine forests.

Under the subject of life history, the development of the queen to a new colony about one year old was discussed. It was mentioned that in some situations, the small new colonies were sometimes found in large numbers. These small new colonies usually do not make noticeable mounds in the first spring, since they are usually only about the size of an inverted teacup. During the following summer they gain in vigor and large numbers of worker ants are produced. At this stage they are still very hard to notice; since their mounds, like most others in the summer and fall, are usually not constructed much above the soil level. During their second winter these new colonies build large mounds that can

be seen easily, since they are about 10 inches in diameter at the ground level and may be 6 to 10 inches tall. The dark phase ants have been studied more closely in this respect, and they frequently have mound populations of about 40 per acre at this stage of development.

During the spring equinoctial rains and storms, the dark phase ants from several neighboring colonies have been found to unite. In this manner it is usual for the mound count of these late second-year colonies to decrease to about 20 per acre during this period. The mounds are usually about 14 to 16 inches in diameter, and they may be about 10 to 14 inches high during the spring. On several occasions giant mounds have been observed. These formed as a result of most or all of the mounds combining from an area as great as 200 feet in diameter. These giant mounds and the associated unfested areas have not been found later than about the first of May, and it is assumed that these united colonies may divide at some time before May.

When colonies are fully two years old, and at the time of the early summer nuptial flights, they seem to reach a stable size and number. There are usually about 20 mounds per acre and most of these measure from 16 to 24 inches in diameter at the ground level. The availability of food seems to limit the number and size of colonies in an area.

As the seasons progress, the stable

number of mounds in a generally infested area usually decline. This may occur for any of several reasons, such as food supply, or perhaps moisture problems. Also colonies sometimes die out. It is not known how long a laying queen may live, or if more than one egg laying queen may exist in a colony. There seems to be some evidence that there is only one functional queen per colony, and there is some evidence that more than one may exist, at least for a time. The imported fire ant differs from the honeybee in this respect, since in the honeybee colony the queen does not tolerate the presence of another queen (even one of her daughters). On a number of occasions several wingless or delated fire ant queens have been observed in the same colony, but their lack of wings is not evidence that they were functional laying queens.

Fire ant queens, unlike queens of the honeybee, do not return to their parent colony following their nuptial flights. It has been noted on several occasions that mated fire ant queens were promptly killed when they landed in an area defended by workers of even small colonies. The presence of a few old colonies in an area seems to be a deterrent to new imported fire ant infestations by mated queens. Very few old colonies scattered about have been found to keep new colonies from developing; but this may be scant comfort to property owners if the old colonies are in objectionable locations.

FEEDING HABITS

The imported fire ant, like other species of fire ants, is considered to be "grease loving. Actually insects or insect products and other animals form the major part of the fire ant diet, as was mentioned earlier. No method has been devised to learn exactly what the food requirements are for their development; but Khan (1965) produced colonies that reared alate brood in nine months in the

laboratory. This was done by furnishing insects as food, supplemented with hamburger meat, and High-Meat Dinner, strained baby food.

Mason (1957) calculated that there were about 60,000 ants that returned to an 18-inch mound in a 24-hour period. It was found in this study that the ants worked night and day at a nearly equal rate. Visual examination of the ants re-

vealed that about 25 percent of them returning from foraging trips were carrying burdens in their mandibles, and all of these burdens were parts of insects. Fire ant mounds can frequently be found in tall grasses due to the dark green color of the grass growing on or near the mounds as a result of the improved soil fertility in the mound area. This is due to the plant nutrients deposited there by the ants.

The various kinds of food used by the ants can often be studied by examining the refuse in their **kitchen midden**, which is often located in a soil depression on the south side of the mound. There are frequently large numbers of bits of arthropod (insects, millipeds, etc.) exoskeletons piled here and quite often enough morphological characters remain to determine what the ants feed on. The ants carefully remove all soft parts of these organisms and leave only the hard skeletal structures.

Although the imported fire ants will scavenge insects that they may find dead, they have been observed to attack and kill live, vigorous and apparently healthy insects such as grasshoppers. These large insects are usually impeded in their escape by the attacks of several ants, and during the struggle many ants may join the fray. They eventually ball up on the appendages of their prey, and all seem to be trying to sting it. In a short time the insect becomes paralyzed and then it is only a matter of time until the ants devour their victim.

Imported fire ants have been observed to attack and kill various kinds of caterpillars for food. Some of those killed were one to two inches long, thus they were many times larger than the ants; but their best efforts of writhing to shake the attacking ants were useless.

The use of termites as a major food source by the fire ant is doubtful, although they are known to feed on them.

Apparently the termites being social insects are able to organize the defense of their galleries against serious attacks. The two insects share the same habitat in many places, such as in young pine timber. This is particularly noticeable where pine harvesting has left stumps and tops for the termites to infest.

The remains of pill bugs or other crustacea are often found in the **kitchen middens** of the imported fire ant. At some times of the year, small terrestrial snails seem to form part of the ant diet also. The seasonal use of such forms for food is probably a result of their activity in the habitat due to favorable moisture conditions, or perhaps it is due to a dearth of insects for food for the ants.

Tests to determine the most acceptable of the families of insects as fire ant food have been inconclusive. The fire ants seem to have very poor receptors to aid in locating their food. Their eyes are not well developed, and apparently they are not readily able to detect the odors of food. Once a source of food is located by an ant it will return to a tunnel leading to its mound. Almost at once other ants appear at the food source. It has been determined that with the proper stimulation, glands at the tips of the abdomens of ants are used to lay down highly volatile, short-lived trails of chemical that can easily be detected by other members of that species. In this manner sister ants are able to find the food source. This is now called a trail finding pheromone.

Chemicals of this type have recently been termed pheromones, though for a time they were called external hormones. They have a wide range of adaptations by insects, and many other animals including man, are known to make use of them.

Another use of pheromones by the fire ant is to spread an alarm among ants when they are busy feeding. It has been

observed that when ants are feeding in large numbers, they do not easily notice an approaching object; however, if one of the ants is disturbed, it will emit an alarm pheromone, which triggers an alarm among all the ants in the group and they immediately hurry to the nearest tunnel. This is a most intriguing phenomenon to observe. The alarm is spread silently in a wave along a line of feeding ants, and their response appears to be to that of a command.

It was mentioned earlier that testing the fire ant preference to various kinds of insects as food was difficult. It can be seen from the feeding habits mentioned here that the first acceptable food they find, largely by chance, is consumed by a trail of ants, and then more food may be sought. Therefore, it is very difficult to get any clearer defined evidence of food preference.

Although the imported fire ant feeds extensively on the bodies of insects which would usually contain large amounts of protein food, this ant is still considered to be a "grease loving" type. Many insects have large fat reserves in their bodies in addition to proteins and other foods; thus the nutritional requirements of the fire ant may be met. The bait material presently used successfully for control of the imported fire ant uses a vegetable oil as a food material. Other baits have been tested that contained peanut butter which has a high oil content. A large number of other oily or greasy foods have been tested and found to be quite acceptable also.

During summer the ants have been found to tend a number of plant sucking type insects to collect a honeydew material secreted by them. They have been

found on stems or leaves of a number of plants tending aphids of several sorts. Also they have been found tending scale insects on limbs of trees. The ants frequently construct "chimneys" or covers around these insects. This helps to protect these insects from their natural enemies. These structures are usually made of soil particles, but plant debris is frequently employed in dry weather. Mealybugs, particularly on the roots of a number of kinds of plants, are also tended by the fire ants, and these too are carefully covered by the ants.

When fire ants are tending a large number of insects on the plant, they sometimes construct a small auxiliary type of mound at the base of that plant. The function of this mound is not understood, however, since the ants are found constantly returning from it to the main mound, and no replete castes of workers have been found.

The need for the sweet honeydew food seems to be largely during the summer when the majority of the brood being produced is that of workers. It is not known if some other carbohydrate source is present in the spring when large numbers of a late reproductive brood forms are being produced; but no great feeding activity on honeydew has been noted. It is difficult to understand how the ants find enough food of any sort to produce the large spring brood. Usually this brood production starts in early March when insects that they would use for food would be at their lowest numbers.

Additional studies are needed on the foods and feeding habits of this ant. Studies are now underway to find some food additives that may improve the bait control presently being used.

FISH KILL BY IMPORTED FIRE ANTS

An interesting phenomena has occurred on several known occasions where bluegill fish and yearling largemouth bass were killed by feeding on fire ants.

It has been reported that masses of ants floated into ponds or lakes following heavy rains in the spring, have been fed on by fish and that this has resulted in

fish mortality. The flights of reproductive forms of the imported fire ants landing in ponds were reported by Green and Hutchins (1960) as causing fish mortality. Both bluegills and yearling bass were found to be killed by feeding on these winged forms when flights of the ants landed on the ponds during the very early spring is unseasonably warm weather. As few as four winged females killed a yearling bass. In laboratory tests it was found that winged females or worker ants could cause fish kill, but males were not toxic. In these tests the ants were macerated and fed to fish in a water suspension with a glass pipette. Death of the fish occurred in a few minutes after the ants were fed to them. The fish would dart about wildly for a short time before they lost their equilibrium and died.

In unpublished reports, other investigators were unable to cause fish mortality by force feeding them on intact ants encased in gelatin capsules. Even repeated feedings in this manner failed to cause fish kill.

The above finding prompted further study in this matter by the author. It was found that several digestive enzy-

mes reported to be present in fish would detoxify the fire ant venom. Thus it appeared that feeding the fish on ants in capsules would allow time for the detoxification of the venom. Ants that were removed from the stomachs of dead fish were partially intact, but it was impossible to say with certainty how badly they had been masticated by the pharyngeal teeth of the fish when they were ingested; since they had been partially digested either before or after the death of the fish.

Most ponds are overstocked with fish, and the loss of even a high percentage of them might be beneficial; but of the scores of cases of fish mortality reported, at least two resulted in the harmful loss of fish. These cases involved extensive fish mortality early in the second year after the ponds were stocked, and this resulted in the loss of the major portions of the potential breeding stocks. The dead fish that were dissected had little food except winged fire ant reproductive forms in their stomachs. At this season of the year (late winter or early spring) very little other food was available to the fish.

FIRE ANT VENOM

It was reported by Adrouny *et al.* (1959), that there are two reactions to fire ant stings from a medical point of view: a local necrosis, or a systemic reaction presumably due to allergy. In this report the necrotoxic principle(s) of the venom were studied. It was found that all of the venom was held in the venom sac attached to the stinger. Venom was found to be a strongly hemolytic nonprotein, soluble in nonpolar solvents such as petroleum ether. The pure venom was Ninhydrin-negative, with an alkaline reaction and gave a positive nitrogen test, but lost its activity with exposure to cation exchangers. Thus it was felt that the homolytic principle was as-

sociated with the alkaline constituents and that it was probably an amine. A simple method of testing the effect of the venom in the laboratory was developed using the erythrocytes of rabbits.

While this study was being made at the Department of Biochemistry at Tulane University in New Orleans, a similar study was being made at the Department of Entomology at Louisiana State University at Baton Rouge. In this study by Blum *et al.* (1958) it was reported that one and possibly two human fatalities from the allergic reactions to fire ant stings had been reported. It was found that the venom was water insoluble, but dispersed in water as fine milky-colored

globules. The venom was composed of an alkaline not (due to metal ions) carrier, with droplets of higher density suspended in it. It was found to be non-proteolytic. Spectro-photometric and spectrograph analyses showed that it was probably non aromatic in nature with a carbonyl group which did not appear to be an open chain simple ketone. It contained both methyl and methylene groups and the globule portion of the venom probably contained most of the carbonyl containing compound.

In addition to the chemical studies mentioned above, Blum and his co-workers found that many common insects could be killed by a topical application of the venom. It did not appear that the fire ant was highly susceptible to its own venom however. The venom ap-

peared to be about as toxic as DDT to some of the insects tested. Instantaneous paralysis resulted from the treatment, and this suggested a sedative type nerve poison. A 1 to 50 dilution of the venom displayed a strong antibiotic action on several bacteria and a variety of molds.

Wilson (1959) suggested that the venom was closely allied to the odor trail material used by foraging worker ants which was mentioned earlier. He demonstrated that the odor trail material was secreted by an accessory gland of the sting apparatus and that the stinger was extruded to lay the trail. He further suggested that venom material might be used by the ants to dilute the odor trail material which could be used in very minute amounts.

CONTROL OF THE IMPORTED FIRE ANT

Most people who have encountered the imported fire ants or have had mounds on their property are strongly in favor of controlling them.

Most people who live on infested properties have attempted in some manner to destroy the colonies, and it has been amusing to hear some of the sadistic schemes that have been tried. No manner of death was considered to be too horrible for the ant. A favorite method described has been the use of gasoline to saturate the mound, and in many cases this method was embellished by setting fire to the gasoline. This method incidentally is not very effective, and it can be very dangerous.

There are two general methods of control of the fire ant that can be stated for use under various conditions: (1) mound treatments by fumigation, or with residual insecticides or baits; (2) area treatments with residual insecticides or baits.

In recent years most of the scientific

writings about the imported fire ants have been concerning various types of control studies. No attempt will be made here to review all of this work; but rather some typical work that have resulted in major change or improvement in the control of the imported fire ant will be cited in a chronological order.

Early control method used against the fire ant included bait, or mound fumigation or insecticidal treatment. Fumigation of fire ant mounds in the field is generally expensive or ineffective and sometimes dangerous. Under some conditions fumigation may be useful however. Most fumigant materials such as methyl bromide, hydrogen cyanide, carbon bisulfide or commercial grain fumigants are highly effective if the gas is confined to allow for complete penetration of the mound galleries. These materials may be used effectively in the field by releasing the fumigant under a tarpaulin to cover the ant mound.

Fumigants injected into mounds with-

out a covering frequently kill many ants, but survivors have been found to move out of the mound with their brood. Under some conditions it was found that surviving ants opened holes in the mound crust to allow ventilation and then reoccupied the mound.

Materials used to treat individual mounds before World War II were generally some type of petroleum product that saturated the mounds, usually with poor results. The advent of the residual synthetic chlorinated hydrocarbon insecticides gave great promise of control, and even hope of eradication of the fire ant. Most of the early formulations of these materials were dusts that were used to treat the mounds and the areas around them. The most effective of these chemicals were chlordane, aldrin or dieldrin.

During the early 1950's methods were developed that made area treatments with the residual insecticides much easier. Formulations of insecticides were developed that could be sprayed at low volumes from newly developed power equipment; and granular insecticide formulation and equipment for their application were also developed.

In the summer of 1955, weather conditions were highly favorable for the survival of new fire ant colonies. This resulted in very large numbers of new colonies becoming evident in many new areas of the southeastern states in January of 1957. The resulting condition has been referred to as the "explosive spread of fire ants." The widespread concern voiced by those in the newly infested areas was soon publicized in many of the news media. As in most cases of alarm or concern, some articles grossly exaggerated the situation. National interest in the problem soon resulted in initiation of an eradication program. It was necessary for this work to proceed with only meager research data on area controls.

Some work in Alabama by Eden and

Garrett (1955) and Blake (1956) had shown that area treatments with residual insecticides would control the imported fire ant. The early eradication program was based largely on these reports where heptachlor gave best results. As more data on control in Mississippi became available (Green and Hutchin, 1958), it was soon possible to design treatments that used much less of the heptachlor insecticide. The USDA Agricultural Research Service, Southern Plant Pest Control Region based in Gulfport, Mississippi, directed the fire ant eradication program. A team of researchers attached to this group studied methods of fire ant treatment to aid in the eradication program. Studies of this team resulted in the adoption of a program of double applications of relatively low rates of heptachlor. This concept of the repeated use of residual insecticides for eradication required much modification of the reasoning concerning the methods of treatment.

Thus it was possible from these studies to recommend a reduction in the amount of heptachlor used, from the originally higher rate of 2 pounds per acre, to 1.25 pounds per acre, and finally to 2 applications, each at 0.25 pounds per acre. These lower rates made the impact of the treatment on other biological forms less drastic.

The problem of insecticide residue hazards has limited the use of heptachlor and other of the residual insecticides. At present, fire ant treatments with residual insecticides are largely restricted to such properties as plant nurseries used in compliance with regulatory requirement designed to avoid the shipment of live ants on nursery stock. Most control and eradication work with fire ants is now done with baits that are fed on by the ants.

For many years food high in greases, oils and protein have been used in poison baits prepared to combat fire ants. The

toxicant used in these baits was thallous sulfate. This material was frequently mixed at a one half percent concentration, and this posed a definite toxic hazard. Since these baits were dangerous and expensive, they had only limited usefulness, usually in homes. The imported fire ants seldom invade homes, however.

Baits are known to be an ideal method for poisoning ants since the egg producing queens of the colonies can be killed in this manner. For this reason, a "slow acting" toxicant for the bait is ideal. Following World War II a large number of synthetic organic insecticides became available; but most of these materials were found to be either repellent to the ants at toxic levels, or they killed the ants on contact.

The first major "breakthrough" came as a result of area spraying tests of a number of candidate insecticides at Mississippi State University. In one of these tests the insecticide Kepone was used to treat some of the plots. Data collected on the short term effects of this material were discouraging as compared to such materials as heptachlor. When the plots were re-examined after several months had passed, all the ants were dead. The manufacturer reported this to other research teams where work with baits was in progress and where there was a need for suitable bait toxicants.

It was soon found that Kepone-peanut butter baits were very effective in killing the fire ants, (Hays and Arant (1960)). The good results with Kepone led to the discovery that Mirex, which is produced by the same company, was even more effective. Studies by the USDA group developed this presently used Mirex. Reports of some of their studies, Lofgren

et al. (1961 and 1963) reveal the scope of their efforts in developing the bait.

Mirex baits of increased potency have been produced and this has decreased the costs, both of the bait and its application without reducing the bait effectiveness. Mirex bait is made by dissolving the toxicant in a partly refined grade of soybean oil, which is then used to treat "corn cob grits," which absorb the soybean oil and act as a carrier. This bait has been effectively applied with aircraft as well as with ground equipment.

In view of the low order of toxicity of this bait, it has been used to treat even municipal and residential areas without harmful effects. Tests at Mississippi State University have shown that individual mounds can be effectively controlled by hand applications of small amount of the bait. This has been done by scattering the bait in the general area of each mound without disturbing the ants, so that feeding activities will continue in a normal manner.

Mirex bait applications have been made most effectively in fair, warm weather in the early spring before the winged reproductive adults are produced. Treated colonies often "die out" slowly, and it may be several months before the death of all the survivors.

At present, research efforts are directed largely toward studies of the biology of the imported fire ant. This is being done to improve the use of baits to try to avoid reinfestations of areas where the ants have been killed.

There has been a general policy of the Plant Pest Control Division of the USDA toward a containment of the imported fire ant on the northern edge of the infested area by using large scale area-wide treatments with baits.

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One Trip Planting Equipment For Cotton



Figure 1. Flat seedbed obtained with drum planter. Note narrow loose ridge directly over the seed. This later slumps to give ideal surface for postemergence operations.

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Summary

A one-pass system of seedbed preparation and planting as developed in this study has proven highly satisfactory in field tests. It offers an opportunity for a reduction in production costs as well as more efficient use of today's high-powered tractors.

In field tests on well-drained sandy loam soils, the drum planter generally gave superior stands. It also provided a good surface for accurate gauging of postemergence sprays.

In the event a heavy roller is used with conventional planting equipment, it should be run prior to planting. The poorest stands and highest compaction over the seed was obtained by rolling after planting.

ONE-TRIP PLANTING EQUIPMENT FOR COTTON

By O. B. WOOTEN, C. D. RANNEY, and F. E. FULGHAM¹

Planting coupled with final seedbed preparation is one of the most critical operations in cotton production. It is a vital factor in obtaining dependable stands and it greatly affects subsequent cultural practices, including harvesting. Three tractors equipped with various tillage and planting machines are normally used by farmers at planting time. Therefore, the development of a unified system of seedbed preparation and planting offers a means of reducing production costs.

In planting research at Stoneville, special consideration has been given to the following objectives:

- (1) Development of methods of consistently obtaining adequate stands
- (2) Elimination of one or more preplanting operations
- (3) Development of better shaped surfaces for operating postemergence weed control machines.

Seedbed Conditioning Equipment

In early efforts to combine seedbed conditioning and planting operations at Stoneville, a regular front-mounted cultivator with sweeps was used in combination with a rear-mounted planter equipped with runner wings. However, the sweeps frequently left hard streaks in the seed zone, which tended to produce erratic planting depths.

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This research was accomplished as cooperative investigations between Agricultural Engineering and Crops Research Divisions, Agricultural Research Service, U. S. Department of Agriculture, and the Delta Branch, Mississippi Agricultural Experiment Station, Stoneville, and is a contribution to Regional Cotton Mechanization Project S-2.

In recent years, final seedbed preparation research has centered around the Stoneville bed blade. This is a horizontal blade with the ends turned up to form a "U". It was designed to attach to the two gang beams of each row of a front-mounted cultivator. The horizontal part of the blade slices through the seedbed, undercutting grass and loosening the soil. A V-shaped bed leveling blade, attached across the cultivator gang beams directly behind and slightly above the bed blade, is used to level the bed to the desired height.

Satisfactory performance of the bed blade and leveler is dependent on positive depth control. This is obtained by using a double-acting hydraulic system. The downward movement of the blade must be accurately controlled so that it can be placed at the same elevation each time it is lowered to the operating position. Final bed height is then gauged from the wheels of the tractor. The equipment has performed satisfactorily in firm, settled beds of sandy loam or mixed soils.

Planting Equipment

The only major changes in cotton planters in the past 20 years have been the addition of improved seed metering and hilldrop attachments. In this period the use of postemergence herbicides has increased dramatically. Proper application of directed sprays requires a smooth seedbed. To obtain the necessary bed surface, farmers have used heavy rollers as an extra operation following the planter. This adds to the already high production costs, and often creates compaction problems over the planted seed.

In developing more effective weed control techniques in cotton, a combination planter and sprayer assembly was designed and constructed. The initial design of the planter was to obtain precision sub-

surface placement of the herbicide EPTC (ethyl N,N-di-n-propylthiolcarbamate). Evaluation tests indicated the combined planting and precision placement of the herbicide was very satisfactory. Field tests comparing this planter with conventional planting equipment and practices were then conducted.

The multiple-row planter used in the tests was designed as a series of individual one-row units. Each unit attached directly to a pair of gang beams on a conventional parallel-acting rear-mounted cultivator. By attaching the units to a rear-mounted cultivator, excellent flotation was provided. This also helped to reduce the overall cost of equipment required in the cotton production program as the rear-mounted cultivator has proved to be an efficient production tool in the high-rainfall areas of the Cotton Belt.

Description of Planter

Beginning at the front, the first part of the planting unit is a steel drum 20 inches

in diameter and 20 inches wide. This drum is welded to an axle that drives the seed plate and hilldrop. The drum gives excellent depth control to a stub furrow opener mounted close behind the drum. The drum also produces a smooth surface for subsequent postemergence operations. Flexible scrapers of rubber belting may be used to prevent a buildup of moist soil on the drum.

A floating linkage behind the drum supports the flat knife coverers and a set of dual 4- by 12-inch presswheels equipped with zero-pressure rubber tires. The flat coverers are designed to move a uniform thin layer of soil into the seed furrow. This eliminates trenches that are caused by some of the more aggressive disk coverers which are currently used. The seed are deposited directly under the crack between the presswheels, which means there is very little pressure directly over the seed. A view of the finished bed is shown in Figure 1 on the cover.

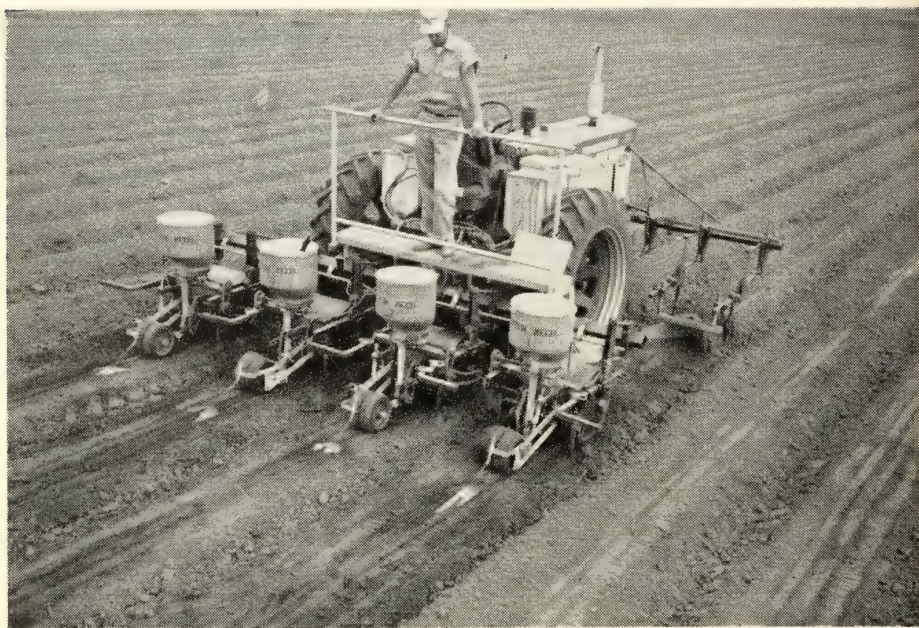


Figure 2. 4-row Stoneville planting rig. Front-mounted bed blades and levelers — rear-mounted drum planters applying band of preemergence material and hopper box fungicide.



Figure 3. Conventional planter with rubber press-wheels. Note row profile after planting.

Field Evaluation

Conventional practices of subsoiling, disking, bedding, fertilizing, and pre-emergence weed control were used in all test plots. Beds were firm and settled at time of planting. Five treatments were included in the original tests. In 1965, another treatment was added to provide a total of six treatments. A split-plot design was used in 1965, and all treatments were run with and without seed firming wheels. However, the seed firming wheels were discontinued in 1966, because of poor results. The treatments included:

(1) Drum planter which was described previously (figure 2).

(2) Drum planter without presswheels, as shown in figure 3.

(3) Conventional planter with zero-pressure rubber presswheels (figure 3).

(4) Conventional planter with a flat steel presswheel.

(5) Conventional planter with rubber presswheels was followed by a weighted steel roller.

(6) After the seedbed had been raked off to planting height, the steel roller was then run over the seedbed and followed by the conventional planter with rubber presswheel.

Soil moisture and bulk density samples were obtained immediately after planting. Soil strength measurements were made with a proving ring cone penetrometer at the beginning of cotton emergence. This covered a period of 6 to 8 days after planting. Stand counts were obtained after the final plant population was established.



Figure 4. Seedbed surface during emergence period, following planting with conventional planter equipped with flat steel presswheels.

Results and Conclusions

Data for the 1964 test is shown in table 1. In this test the best stands were obtained with the Stoneville drum planter. Immediately after the planting operation, soil bulk density was about the same for all planting combinations; however, at time of emergence the soil strength was increased on all treatments where pressure was applied directly over the seed, as compared with the drum planter. Emergence was reduced by 63.5 percent where the weighted roller was used.

In 1965 the use of the roller after planting, as contrasted to rolling before planting, significantly reduced both stands and yields (Table 2). No rain fell on the plots from planting to May 15. The average daily soil temperature at the 2-inch level was 83.3° F. Evaporation averaged 0.28

inch daily. Since no advantages were gained with the seed firming wheel, it was eliminated from further consideration. These data show that stands were improved with the drum planter without presswheels under dry conditions. It appeared that the conventional planter plots were more susceptible to drying than other plots. There were significant differences in yields as well as between stands.

Early and late planted tests were conducted in 1966. There were no significant differences in stands or yields in the early-planted tests. Again, the highest soil strengths were where the roller followed the planter (table 3).

The late test is summarized in table 4. In this test the planter followed by the steel roller produced significantly lower stands. This treatment also had the highest soil compaction at time of emergence.



Figure 5. Weighted steel roller. This was run ahead of the conventional planter with rubber wheels, and in another treatment it was run after planting.

There were no significant differences in yields, probably due to both the late planting date and an early freeze.

The following conclusions apply to planting operations on well-drained sandy loams with adequate soil moisture at time of planting: (1) The one-pass operation with the combination bed conditioning blades and drum planter arrangement conserves soil moisture since the beds assume their final shape immediately before seed

deposit, (2) the drum planter minimizes compaction problems created during planting, and (3) the probability of obtaining adequate stands on the well-shaped seed-bed are good.

When using conventional planting equipment, the probability of obtaining good stands is higher if the roller is run prior to planting instead of following the planter.



Figure 6. Long axle arrangement with seed press-wheel, using surface presswheels as gauges for coverers exerting no pressure over or around planted seed.

Table 1. The effects of planting equipment on soil strength, cotton stands, and yield, Bosket very fine sandy loam, planted April 15, 1964, Stoneville, Mississippi.

Planting equipment	Soil moisture Pct.	Soil bulk density Gm./cc.	Soil strength ¹ Lb./in. ²	Stand Plants/A.	Hill per acre	Yield seed cotton per acre Lb.
Stoneville drum planter with presswheels	18.1	1.26	38.12 bc	38,236a	7,078a	3,173
Stoneville drum planter without presswheels	18.3	1.05	16.76a	31,745a	6,751 b	3,182
Conventional planter. rubber presswheel	18.2	1.21	33.26 b	23,888 b	5,520 c	3,194
Conventional planter. steel presswheel	18.5	1.23	46.54 c	20,320 bc	5,780 b	3,044
Conventional planter. rubber presswheel followed by roller	18.4	1.27	92.14 d	13,959 c	4,082 d	2,874

¹Means followed by the same letter are not significantly different at the 0.05 level as measured by Duncan's New Multiple Range Test.

Table 2. The effects of planting equipment on soil strength, cotton stands, and yields, Bosket very fine sandy loam, planted May 4, 1965; all treatments with and without seed firming wheels.

Planting equipment	Soil moisture ¹ Pct.	Bulk density ¹ Gm./cc.	Soil strength ¹ Lb./in. ²	Plants per acre, seed firm wheel		Yield seed cotton per acre, seed firm wheel	
				Yes	No	Yes	No
Drum planter, without presswheels	17.1	1.09	67.6 c	40,736	43,228	2,661	2,621
Drum planter with presswheels	16.3	.985	54.8 c	39,788	39,239	2,613	2,593
Steel roller, conventional planter, rubber presswheel	10.9	1.31	94.0 b	34,104	35,251	2,561	2,593
Conventional planter, steel presswheel	12.8	1.24	87.0 b	26,625	33,156	2,440	2,589
Conventional planter, rubber presswheel	13.5	1.25	84.0 b	27,124	27,722	2,364	2,440
Conventional planter, rubber presswheel, steel roller	11.1	1.30	134.4a	23,733	26,476	2,066	2,320
Average for seed firm wheel			32.020	34,179		2,450	2,525
L.S.D. at 0.05 level			774			N.S.	

¹Data for treatments without seed firming wheels.²Means followed by the same letter are not significantly different at the 0.01 level as measured by Duncan's New Multiple Range Test.³Means followed by the same letter are not significantly different at the 0.05 level as measured by Duncan's New Multiple Range Test.

Table 3. The effects of planting equipment on soil strength, cotton stands, and yields in cotton planted on Bosket very fine sandy loam soil on May 6, 1966, Stoneville, Miss.

Planting equipment	Soil moisture	Soil bulk density	Soil strength ¹	Stand ²	Hill per acre ²	Yield seed cotton per acre ²
	Pct.	Gm./cc.	Lb./in. ²	Plants/A.		Lb.
Drum planter with presswheels	20.94	1.26	70.2 b	19,012	5,739	2,186
Drum planter without presswheels	21.76	1.17	78.0 b	19,261	5,739	2,145
Conventional planter, rubber presswheel	23.15	1.28	57.8 b	21,357	5,639	2,182
Conventional planter, steel presswheel	23.76	1.27	69.8 b	20,409	5,888	2,530
Conventional planter, rubber presswheel, steel roller	23.08	1.37	107.0a	19,711	5,739	2,178
Heavy roller, conventional planter, rubber presswheel	22.53	1.31	101.8a	23,453	5,988	2,289

¹Means followed by the same letter are not significantly different at the 0.05 level as measured by Duncan's New Multiple Range Test.

²Differences are not significant.

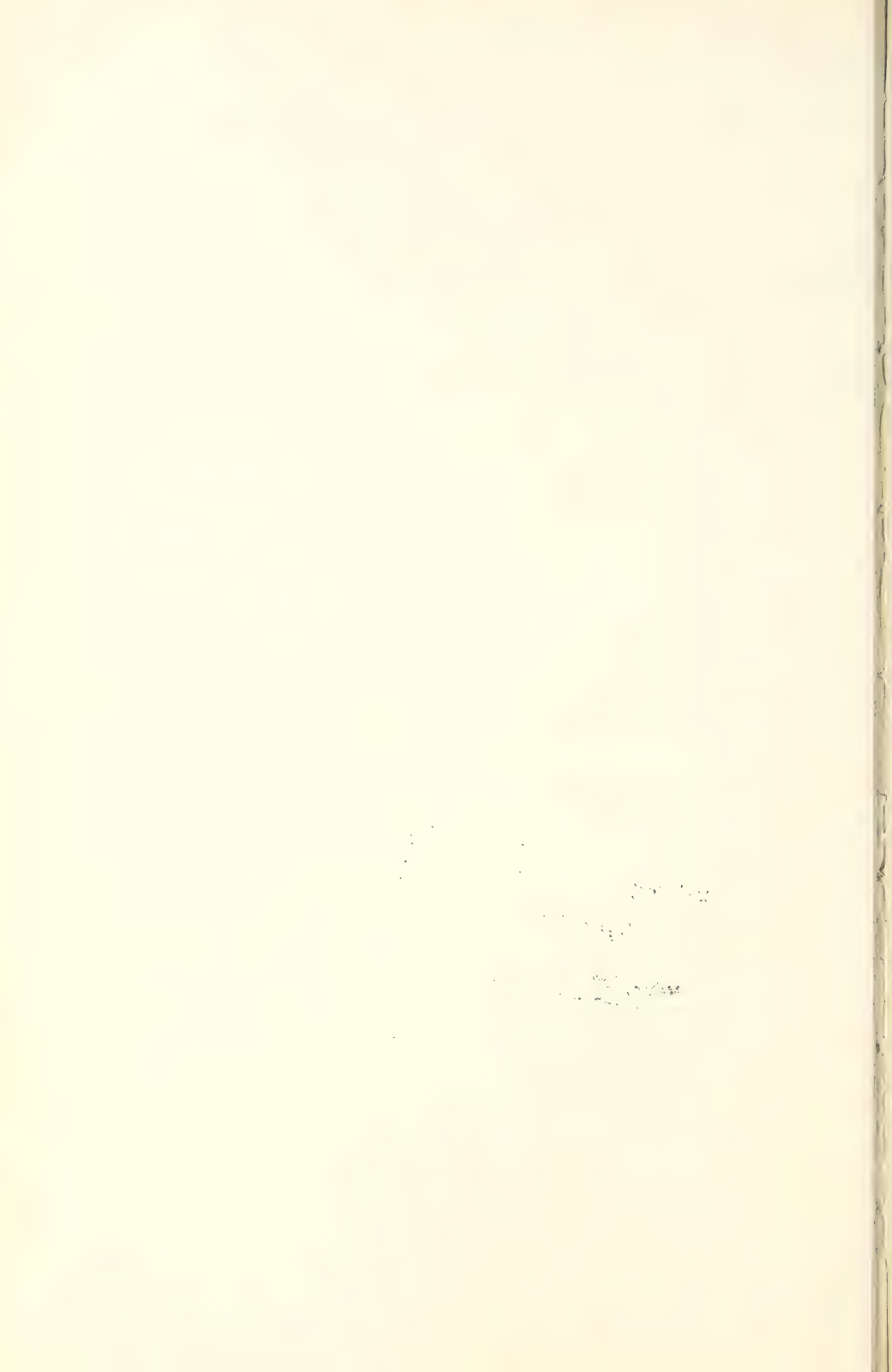
Table 4. The effects of planting equipment on soil strength, cotton stands, and yields in cotton planted on Bosket very fine sandy loam soil on May 27, 1966, Stoneville, Miss.

	Soil moisture	Soil bulk density	Soil strength ¹	Plants per acre ¹	Hills per acre	Yield seed cotton
	Pct.	Gm./cc.	Lb./in. ²			Lb./A.
Drum planter with presswheels	19.27	1.32	84.6ab	28,846a	5,639ab	1,544a
Drum planter, no presswheels	17.66	1.24	66.8 bc	23,004a	5,240 b	1,532a
Conventional planter, rubber presswheels	17.05	1.27	60.8 c	26,846a	5,040 bc	1,631a
Conventional planter, steel presswheels	15.05	1.34	64.6 c	25,699a	5,439 b	1,668a
Conventional planter, rubber presswheel followed by roller	16.51	1.41	98.0a	15,519 b	4,441 c	1,325a
Roller, conventional planter, rubber presswheel	17.30	1.29	84.6ab	30,239a	6,238a	1,855a

¹Means followed by the same letters are not significantly different at the 0.05 level as measured by Duncan's New Multiple Range Test.

²Means followed by the same letter are not significantly different at the 0.01 level as measured by Duncan's New Multiple Range Test.

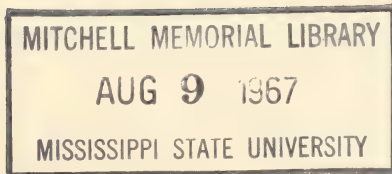




Cotton Harvesting In The Yazoo - Mississippi Delta

An Analysis of Total Harvesting Costs,
Labor Requirements, and Picking Efficiency
by Method of Harvest

By MORRIS M. LINDSEY and
ARTHUR M. HEAGLER



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SUMMARY

This report is designed to provide individual farmers with information that can be used in evaluating each cotton harvesting alternative or various combinations of these alternatives that might be under consideration.

Hand harvesting costs consist of two distinct elements, (1) a per unit picking cost based on a set charge per harvested unit, and (2) a per unit overhead cost that decreases as size of crew and/or yield per acre increases. Farmers generally underestimate hand harvesting costs by overlooking the overhead costs associated with the operation.

Harvesting costs for owned machines represent the total cost for picking the entire expected yield in a twice over operation. When owned machine use is low relative to capacity, harvesting costs per acre are extremely high, ranging from about \$55 for the used one-row machine to \$76 for a new one-row machine. As machine use is increased to relatively high levels the two-row machine has the lowest harvesting costs per acre, followed by the used and then the new one-row machine.

Most cotton producers can reduce total harvesting costs by using some mechanical harvesting alternative when yield

levels exceed 300 pounds of lint per acre. Low yield expectations (under 300 pounds) make custom picking the cheapest harvesting alternative. Owned machine alternatives rapidly replace custom machines as the cheapest alternative when yield levels exceed 500 pounds per acre.

Combinations of harvesting alternatives should be carefully evaluated. In many instances moderate levels of hand picking may affect the total harvesting costs of the owned machine and hand picking alternatives so adversely that custom machine and hand picking becomes the cheapest alternative.

Evaluation of harvesting alternatives is somewhat different if a mechanical cottonpicker is already owned. Per acre harvesting costs for any owned machine is its per acre operating cost. Thus, a farmer owning a one-row and two-row machine would use the two-row machine as intensively as possible since its per acre operating costs, twice over, is \$11.62 compared to \$14.78 for one-row machine. Other alternatives would not be used unless their per acre harvesting costs are lower than the owned machine operating cost or the owned machine is being used at maximum capacity and isn't able to harvest the entire crop.

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COTTON HARVESTING IN THE YAZOO-MISSISSIPPI DELTA

By MORRIS M. LINDSEY and ARTHUR M. HEAGLER¹

INTRODUCTION

The Yazoo-Mississippi Delta² cotton crop of 1,310,000 bales in 1963 cost Delta farmers an estimated 25 million in harvesting costs. The major portion, 70 to 80 percent, of this large expenditure occurred during a 6- to 7- week ginning period in September and October. Cotton production and production costs are of vital importance to the producer but harvesting is the end measure of a successful crop.

The mechanical cottonpicker was generally introduced and gained rather widespread acceptance during and immediately following the war years of the 1940's. Previously, hand picking accounted for harvesting the major portion of the Delta cotton crop. At mechanization levels that existed during the late 1940's, it was estimated that about 85 percent of the total labor required for cotton production was expended during harvesting if the crop was picked by hand.

As the quantity and quality of hand labor used in hand picking the cotton crop has decreased over the last 10 years, the mechanical cottonpicker has accounted for increasing percentages of the total yield table 1. The percentages indicated in table 1 are for the entire State and not for the Delta where larger fields

and bigger allotments per farm have resulted in greater use of the mechanical picker. It has been estimated that over 80 percent of the 1963 Delta cotton crop was harvested by the mechanical cottonpicker.

Although the mechanical cottonpicker is in almost universal acceptance on the larger cotton farms in the Delta, many operators are still concerned with certain aspects of mechanical harvesting. Farmers are seeking to compare the economic feasibility of hand picking during the early season in an attempt to obtain a premium product as against waiting until some 65 percent of the crop is open and using the mechanical harvester. At the other end of the harvesting scale, operators would like to know when and what amount of cotton remaining in the fields would not justify the use of the mechanical picker. Since hand picking costs will depend upon the poundage picked and not upon yield per acre it is logical to assume that hand picking will continue as long as hand pickers feel economically justified in going to the fields.

Other problems that the operator would like answered concern themselves with

Table 1. Percentage of the Mississippi cotton crop picked by hand and machine, 1956-1964.¹

Year	Hand	Machine
	Percent	Percent
1956	78	22
1957	75	25
1958	69	31
1959	62	38
1960	60	40
1961	52	48
1962	42	58
1963	35	65
1964	31	69

¹Agricultural Economists, Farm Production Economics Division, Economic Research Service, United States Department of Agriculture, stationed at the Delta Branch of the Mississippi Agricultural Experiment Station, Stoneville, Mississippi, when the study was made. Mr. Lindsey is now deceased and Mr. Heagler is stationed at Louisiana State University, Baton Rouge, Louisiana.

²For the remainder of this report the Yazoo-Mississippi Delta will be normally referred to as "the Delta."

¹Mississippi Crop and Livestock Reporting Service, Supplement No. 6, 1965.

the choice of one-row and two-row machines, used and new machines, the use of rented machines, hiring custom picking by machine, and any combination of these methods that will minimize picking costs. Picking efficiencies of mechanical pickers and grade reduction, because of an increase in foreign matter in mechanically picked cotton, are still

matters that vitally concern the farmer. Gin turnout percentages and the increased ginning cost for machine picked cotton is still another point of interest in the harvesting picture. Farm operators need additional information that will aid in decision-making when they are confronted with selecting the cheapest way of harvesting a cotton crop.

SOURCE OF DATA

Harvesting costs for hand-picked and machine-picked cotton were collected from Delta farmers in 1961 and 1962. The operation of 20 one row and 11 two-row mechanical pickers was studied in detail to determine fixed and operating costs. Picking efficiency for these machines was also determined for first and second pickings in each of the two seasons. In addition, economists and engineers have determined the picking efficiency for certain machines and planting patterns on the Delta Branch Experiment Station for the last five seasons.

Additional budgetary information was available through the S-42 project which is a regional farm management study

conducted by the U. S. Department of Agriculture and Southern Land - Grant Colleges. Average grade, staple, and gin turnout percentages were available from a recently completed study³ at the Delta Experiment Station. Custom charges for mechanical harvesting were available from a study of custom work⁴ for Delta farms in 1963.

³"The Effect of Harvesting Conditions on Cotton Quality in the Yazoo-Mississippi Delta," Lindsey, M. M., Mississippi Agricultural Experiment Station, Bulletin No. 695, July 1964.

⁴"An Economic Analysis of Custom Work on Farms in the Yazoo-Mississippi Delta," Lindsey, M. M., Mississippi Agricultural Experiment Station Bulletin No. 667, June 1963.

METHODS OF HARVEST

The two basic harvesting methods employed in the Delta are machine picking and hand picking. However, within these two methods are any number of harvesting practices that may be utilized by the operator. Hand picking may be performed by labor residing on the farm, by off-farm labor that commutes to the farm as individuals, or by crew labor or dayhaul labor that reports to the farm as a unit complete with foreman and weigher.

Mechanical harvesting may be performed by owned machine; either one-row or two-row units which may have been purchased new or used. Other

machines may be rented on a cash basis although this practice is new in the Delta. A more common method of mechanical harvesting is through the use of a custom picking service in which the custom operator picks on the basis of a specified fee per pound of lint.

Mechanical "stripping" and hand snapping are rarely used as harvesting methods in the Delta, however, some late season hand-picked cotton will exhibit many of the characteristics of hand-snapped cotton. The retrieval of cotton dropped on the ground by machines and storms is insignificant at the present time.

Hand Picking

In addition to the steady decrease in the percentage of the Delta cotton crop picked by hand, there has also been a decrease in the quality of hand-picked cotton. Several reasons have been advanced for the grade reduction in hand-picked cotton in the last 10 to 15 years.

First, the bulk of hand picking is now done by women, children, and older people. Those of young adult males who have not joined the general exodus to industrial areas are employed as tractor and specialized power equipment operators. The decrease in pounds of seed cotton picked per man hour, even though average yield per acre is increasing, is probably due largely to the age and make-up of the picking crew.

Second, hand pickers are aware of the great technological strides made in ginning cotton containing large amounts of foreign matter, and since they are paid on the basis of poundage picked, see little need for careful picking as the practice may actually reduce their returns from harvesting.

The third reason stems from the reluctance of the ginner to adjust his complicated high - speed equipment to match the requirements of hand and machine picked cotton. In most cases the same machinery adjustments are maintained for both hand and machine-picked cotton. This practice will often reduce the grade of carefully hand-picked cotton since the gin was adjusted for

cotton bearing a much higher percentage of foreign matter.

Pounds of seed cotton harvested per hand picker has declined steadily during the last 10 to 15 years. Plantation wage records and cotton weigh sheets of the period 10 to 15 years ago indicated that a per hour harvesting rate of 25 to 30 pounds of seed cotton per picker was quite common. Even with the relaxed attitude of today's hand picker toward foreign matter, the bulk of the hand pickers do not average over 20 pounds of seed cotton per hour. This fact, coupled with the dwindling supply of general farm labor, would indicate that hand labor would be hard pressed to make any sizeable in roads into harvesting present Delta Cotton production.

Efficiency of Hand Harvesting. Farm operators are often prone to think of hand harvesting as the ultimate in picking efficiency. A 4-year test, 1960-1963, indicated that hand harvesting was much more efficient than machine harvesting, but did not approach 100 percent efficiency. The efficiency of hand picking ranged from a high of 97.3 percent in the 1963 season to a low of 96.1 percent in the 1961 season, table 2. The average lint loss of 21.2 pounds per acre would indicate an average seed cotton loss of about 65 pounds per acre. Although the percentage of loss varies by as much as a percentage point, the actual loss of lint cotton per acre varies only slightly. This would suggest that farmers feel that it is not economical to pick cotton

Table 2. Picking efficiency and percentage of loss of hand-picked cotton by year, Yazoo-Mississippi Delta, 1960-63.

Year	Lint yield per acre	Lint loss per acre	Percentage of efficiency	Percentage of loss
	Pounds	Pounds	Percent	Percent
1960	531	19.6	96.3	3.7
1961	576	22.5	96.1	3.9
1962	606	20.6	96.6	3.4
1963	811	21.9	97.3	2.7
Average	631	21.2	96.6	3.4

Source: Cotton Production and Harvesting Investigations, Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture in cooperation with the Delta Branch, Mississippi Agricultural Experiment Station. Unpublished data.

that yields 65 pounds or less of seed cotton per acre. This average harvesting loss would amount to a cost of \$6.36 per acre with lint valued at 30 cents per pound.

Grade and Staple of Hand Harvested Cotton. A recent report⁵ of the Delta Branch Experiment Station presented a detailed analysis of cotton quality as affected by harvesting conditions. Early season hand-picked cotton graded 99.6 index point (Middling White = 100.0) or just below Middling White. Cotton picked by hand during the middle harvesting season, the 6-week period of heaviest ginning concentration, graded 97.83 index points or slightly better than Strict Low Middling plus grade. Late season hand-picked cotton had an average grade index of 90.81 or almost one index point better than Low Middling plus grade.

Average staple length of hand-picked cotton was almost identical in the early and middle harvesting seasons and was slightly less than 1-1/16 inches. The late season hand-picked cotton had an average staple length of just under 1-1/32 inches.

Gin Turnout and Waste. Gin turnout percentages for hand-picked cotton were 33.93 percent for early season cotton, 32.64 percent for middle season cotton, and 29.27 percent for late season cotton. Waste, which included all foreign matter plus moisture, varied considerably by harvesting season. Early season cotton had 8.66 percent waste; middle season cotton had 10.98 percent; and late season cotton exhibited a 20.42 percent waste content.

Picking Costs. The cost of hand picking Delta cotton production does not vary by yield or percentage of the crop that is "open," but varies according to price per hundredweight picked plus certain overhead costs. The overhead costs

are difficult to determine because they are affected by yield differences, variations, harvesting rates, and in the size of the picking crew.

Since it is estimated that less than 15 percent of the Delta cotton crop is hand picked, a detailed analysis of picking cost by picking season reveals no major costs differences. Early season hand harvesting accounts for about 30-35 percent of all hand picked cotton, the 6-weeks middle season accounts for 35-40 percent of hand harvesting and the remainder of the hand-picked crop, 25-35 percent, is scrapped between weather disturbances in late fall and winter.

Prices paid for hand harvesting are usually quite low at the beginning of the early hand picking season and tend to increase to peak wages during the late early season and the first half of the middle hand harvesting season. The bulk of this hand harvesting is confined to smaller farms and fields and to "end picking"—a term applied to hand harvesting the first few feet of each row to allow room for the mechanical harvester to turn around in the field. Prices paid for hand picking during recent years ranged from about \$2 per hundredweight in the early season to \$3 per hundredweight at the peak of the hand harvesting season. In addition, farmers often pay a "crew foreman" a 25-50 cent "head charge" for assembling, transporting, and returning a crew of pickers. Resident farm labor and independent hand pickers who commute to the fields by their own means are usually not paid this fee. Early and late harvesting season picking wages will average \$2.25 - \$2.50 and middle season prices \$2.75 - \$3.25 per hundredweight harvested.

Table 3 presents the overhead costs for hand picking during the middle harvesting season by lint yield per acre and by size of the picking crew. The over-

⁵Lindsey, Op. Cit., table 15, p. 37.

Table 3. Overhead cost per hundred pounds of lint, by yield per acre and size of crew, hand picked cotton, middle season, Yazoo-Mississippi Delta, 1963.

Item	Unit	Lint yield per acre — pounds								
		100	200	300	400	500	600	700	800	900
Seed cotton yield										
per acre	Cwt. ¹	3.06	6.13	9.19	12.25	15.32	18.32	21.45	24.51	27.57
Man-hours per acre ²	Number	15.30	30.65	45.96	61.25	76.60	91.90	107.25	122.55	137.85
15 man crew										
Weigher ³	Dollar	.76	.76	.76	.76	.76	.76	.76	.76	.76
Water boy ⁴	Dollar	.36	.36	.36	.36	.36	.36	.36	.36	.36
Trailer ⁵	Dollar	.24	.24	.24	.24	.24	.24	.24	.24	.24
Tractor ⁵	Dollar	1.79	.89	.66	.45	.36	.30	.26	.22	.20
Total	Dollar	3.15	2.25	1.96	1.81	1.72	1.66	1.62	1.58	1.56
25 man crew										
Weigher ³	Dollar	.46	.46	.46	.46	.46	.46	.46	.46	.46
Water boy ⁴	Dollar	.21	.21	.21	.21	.21	.21	.21	.21	.21
Trailer ⁵	Dollar	.14	.14	.14	.14	.14	.14	.14	.14	.14
Tractor ⁵	Dollar	1.79	.89	.60	.45	.36	.30	.26	.22	.20
Total	Dollar	2.60	1.70	1.41	1.26	1.17	1.11	1.07	1.03	1.01
40 man crew										
Weigher ³	Dollar	.29	.29	.29	.29	.29	.29	.29	.29	.29
Water boy ⁴	Dollar	.13	.13	.13	.13	.13	.13	.13	.13	.13
Trailer ⁵	Dollar	.09	.09	.09	.09	.09	.09	.09	.09	.09
Tractor ⁵	Dollar	1.79	.89	.60	.45	.36	.30	.26	.22	.20
Total	Dollar	2.30	1.40	1.11	.96	.87	.81	.77	.73	.71

¹Middle season gin turnout on seed cotton 32.64 percent.²Hand harvesting rate of 20 pounds seed cotton per man-hour.³Wage rate 75 cents per hour.⁴Wage rate 35 cents per hour.⁵Performance rates and costs taken from "Budgets for Major Farm Enterprises in the Mississippi River Delta of Arkansas, Louisiana, and Mississippi," Mississippi State University, AEC M.R. No. 39, June 1961.

head costs of the weigher, water boy, and the cotton trailer do not vary to any significant degree by yield per acre but are affected only by size of the picking crew. The tractor used to pull the trailers to the field and "spot" them at convenient locations and to haul the harvested cotton to the gin is not significantly affected by size of the picking crew but is affected by the yield per acre. As yield increases the tractor overhead cost per hundred pounds of lint decreases proportionately.

Total overhead cost in the 6-week middle harvesting season, would amount to \$5.86 per 500 pound bale harvested, assuming a 25-man picking crew. With actual picking costs at \$3.00 per hundredweight, the 1,532 pounds of seed cotton needed for a 500-pound bale would cost \$45.96 plus the \$5.86 overhead cost for a total harvesting cost of \$51.82 per bale. Assuming the same picking cost of \$3.00 per hundredweight, hand picking in cotton yielding approximately one-quarter bale per acre would exhibit a total harvesting cost of just over \$53.00 per bale. In cotton yielding one and one-half bales per acre, the total harvesting costs would be reduced to about \$51.00 per bale. A difference of 25 cents per hundredweight in out-of-pocket picking cost will affect total harvesting costs more than varying the crew size from 25 men to 40 and changing yields from one-half bale to one and one-half bales per acre.

Mechanical Harvesting

Delta farmers have been moving rapidly away from the hand picker as the major means of gathering the cotton crop. Mechanical picker numbers have been increasing steadily, table 4, and the movement from one to two row machines has further accelerated this trend. Agricultural specialists believe that Del-

ta farmers could harvest their entire crop within a 30-day period under optimum conditions with the machines presently on farms.

The grade differentials between machine and hand harvested cotton are not as great as once supposed.⁶ Three broad inter-related factors are primarily responsible for this change. First, intensive mechanical harvesting research has produced regional and local machine adjustment and -operation guides that permit an individual farmer to correct most of the malfunctions causing a decrease in fiber quality and/or picking efficiency. This information has been disseminated throughout the area, and is used by almost all cotton producers. Second, farmers have altered their production systems and practices to facilitate machine harvesting. Third, ginners have made major changes in their drying and cleaning machinery and are now able to handle machine harvested cotton without excessive grade loss.

A previous study indicated that in 1960 about 77 percent of the total Delta cotton crop was harvested prior to November 19. Mechanical pickers harvested 52 percent of the crop during this period. However, a major portion (86 percent) of

Table 4. Number of mechanical cottonpickers on farms by size of machine, Yazoo-Mississippi Delta, 1957-1964.¹

Year	Size of machine		Total heads ²
	One-row	Two-row	
	Number	Number	
1957	1,921	0	1,921
1958	1,945	3	1,945
1959	2,083	284	2,651
1960	2,159	682	3,523
1961	2,219	1,181	4,581
1962	2,225	1,480	5,185
1963	2,191	1,831	5,853
1964	2,215	1,988	6,191

¹"1964 Farm Report," Mississippi Employment Security Commission, Jackson, Mississippi.

²One head per one-row machine, two heads per two-row machine.

⁶Lindsey, Op. Cit., table 15, page 37.

the total bales machine picked were harvested during this time. As machine numbers and heads have increased, considerable changes in the harvesting pattern have occurred. The percentage of the crop harvested in the early and late seasons has declined, and an even larger portion of the crop is harvested by machine during the 6-week period prior to November 19.

Efficiency of Machine Harvesting. Cotton harvesting studies conducted at Stoneville indicate that mechanical cotton pickers leave more cotton in the field during harvest than hand pickers. However, the difference between machine and hand picking efficiency is small when normal rainfall patterns occur during the harvest season. In tests at the Delta Station, the efficiency of machine picking ranged from a high of 94.2 percent in 1963 to a low of 84.2 percent in 1960, table 5. This wide variation in efficiency clearly illustrates the effect of weather: two harvest seasons with normal rainfall occurred (1961-1963) during the study period and high levels of efficiency were obtained. Two harvest seasons with adverse rainfall also occurred (1960-1962) and efficiency levels were low. Harvesting losses under normal rainfall conditions would amount to a cost of \$15.90 per acre with lint values at 30 cents per pound.

Grade and Staple of Machine Harvested Cotton. Cotton harvested mechanically during the early season graded 97.1 index points (Middling White.....100.0) or Strict Low Middling Plus. During the middle harvesting season, machine picked cotton graded 93.1 index points or just below Strict Low Middling. Late season machine picked cotton had an average index of 85.8 or just above Low Middling.

Staple length of early and middle season machine harvested cotton were almost identical, averaging a little over 1-1/32 inches. Late season machine harvested cotton had an average staple length just under 1-1/32 inches.

Gin Turnout and Waste. Gin turnout percentages for machine harvested cotton were 33.48 percent for early season cotton, 32.47 percent for middle season cotton, and 30.21 percent for late season cotton. Foreign matter increased as the harvest season progressed. Early season cotton contained 10.40 percent waste, middle season cotton contained 13.25 percent waste, and late season cotton 16.90 percent waste.

Picking Costs. Mechanical harvesting costs are a combination of fixed costs (depreciation and interest) and operating costs (repairs, fuel, oil, grease, and labor) associated with a harvesting machine and its trailer complement. Fixed

Table 5. Picking efficiency and percentage of loss of machine-picked cotton by year, Yazoo-Mississippi Delta, 1960-63.

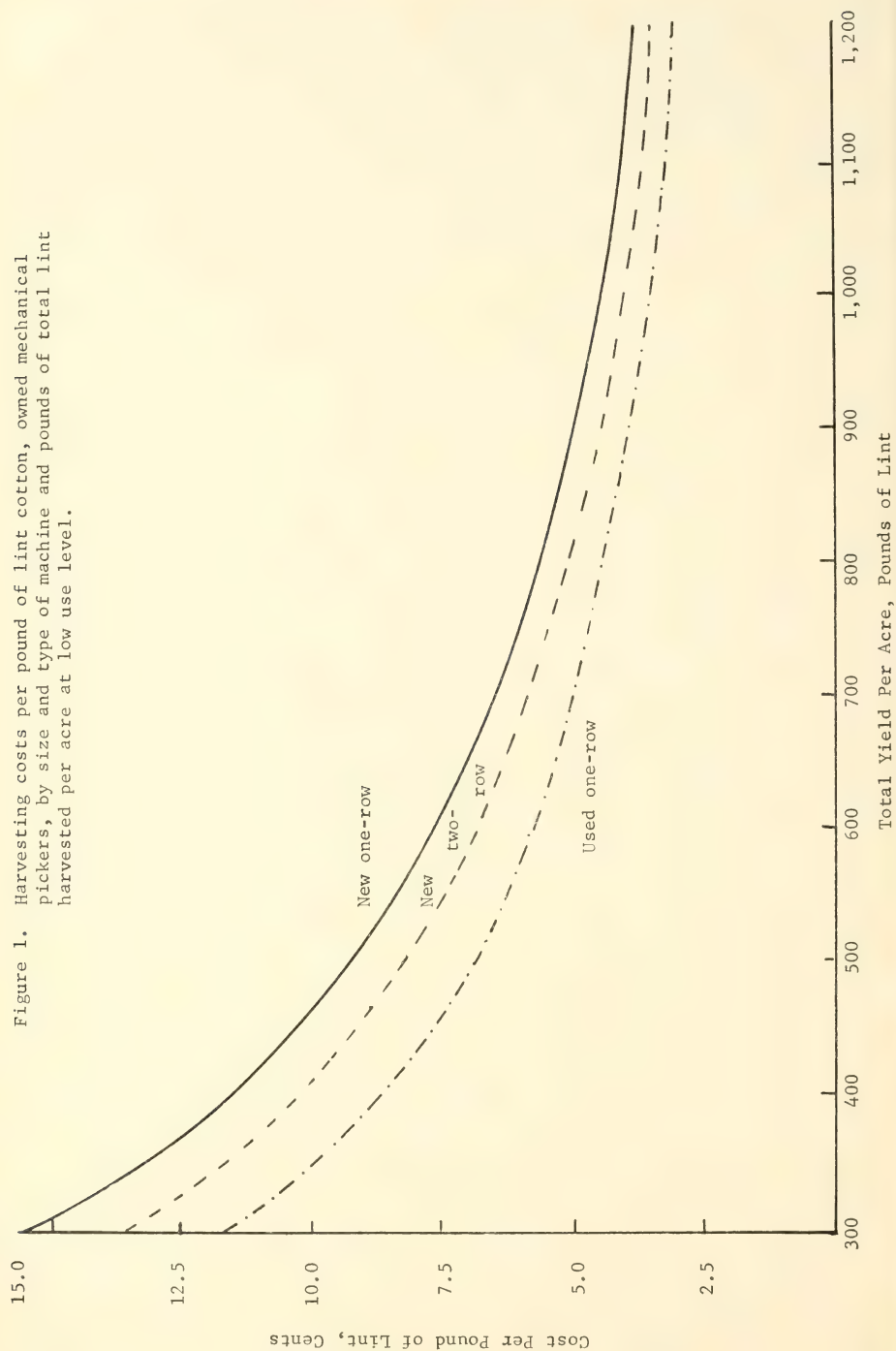
Year	Lint yield per acre pounds	Lint loss per acre pounds	Percentage of efficiency ¹ percent	Percentage of loss percent
1960 ²	531	83.9	84.2	15.8
1961	576	43.8	92.4	7.6
1962	606	76.9	87.3	12.7
1963	811	63.2	94.2	5.8
Average	631	67.0	89.5	10.5

¹International Harvester 120-A high-drum picker

²Yield and picker efficiency data were depressed because of drought conditions during growing season and severe boll rot problems prior to picking.

Source: Cotton Production and Harvesting Investigations, Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture in cooperation with the Delta Branch, Mississippi Agricultural Experiment Station. Unpublished data.

Figure 1. Harvesting costs per pound of lint cotton, owned mechanical pickers, by size and type of machine and pounds of total lint harvested per acre at low use level.



costs for any machine and trailer complement should be allocated over the total acres of cotton a farmer plans to harvest and will decrease as the total acres harvested increase up to the capacity of the machine. Considerable differences in the total and per acre fixed costs occur among machines with the same capacity, but of different conditions (purchased new or used) and among machines with different capacities but like condition (one-row and two-row either new or used.) Conversely, per acre operating costs for any machine and trailer complement does not change as the acres harvested increases or decreases.

Appendix tables 1, 2, and 3, contain a detailed breakdown of harvesting cost per acre twice over for new and used one-row machines and new two row machines with varying amounts of use. The data presented in these tables represent the costs associated with picking each acreage situation over twice since this is the practice used by most Delta farmers. If a third picking or scrapping operation was performed the per acre operating costs shown in these tables would have to be increased one-half while the other costs would remain unchanged.

Variation in machine performance⁷ is indicated by the difference in acres harvested at each use rating category. However, it should be pointed out that there is little difference in the total hours used by any machine at each use rating level. Picking costs per acre for various machines with a low use rating range from a high of \$45.56 for a new one-row machine to a low of \$34.66 for a used one-row machine with a two-row machine falling in between (\$40.50). With average use the new one-row machine still has the highest picking cost (\$30.23) and

the used one-row machine the lowest cost (\$24.70). The two-row machine still lies in between and close to the used one-row machine.

Selection of the correct owned machine and trailer complement is accomplished by comparing the cost per unit for the harvested crop of the various owned complements being considered. This can be done once the acres to be harvested is fixed and the various machine and trailer complement costs associated with harvesting these acres are determined. Appendix tables 4, 5, and 6 present harvesting costs per pound of lint by acres harvested and list yield per acre for new and used one-row cotton-pickers and new two-row cottonpickers.

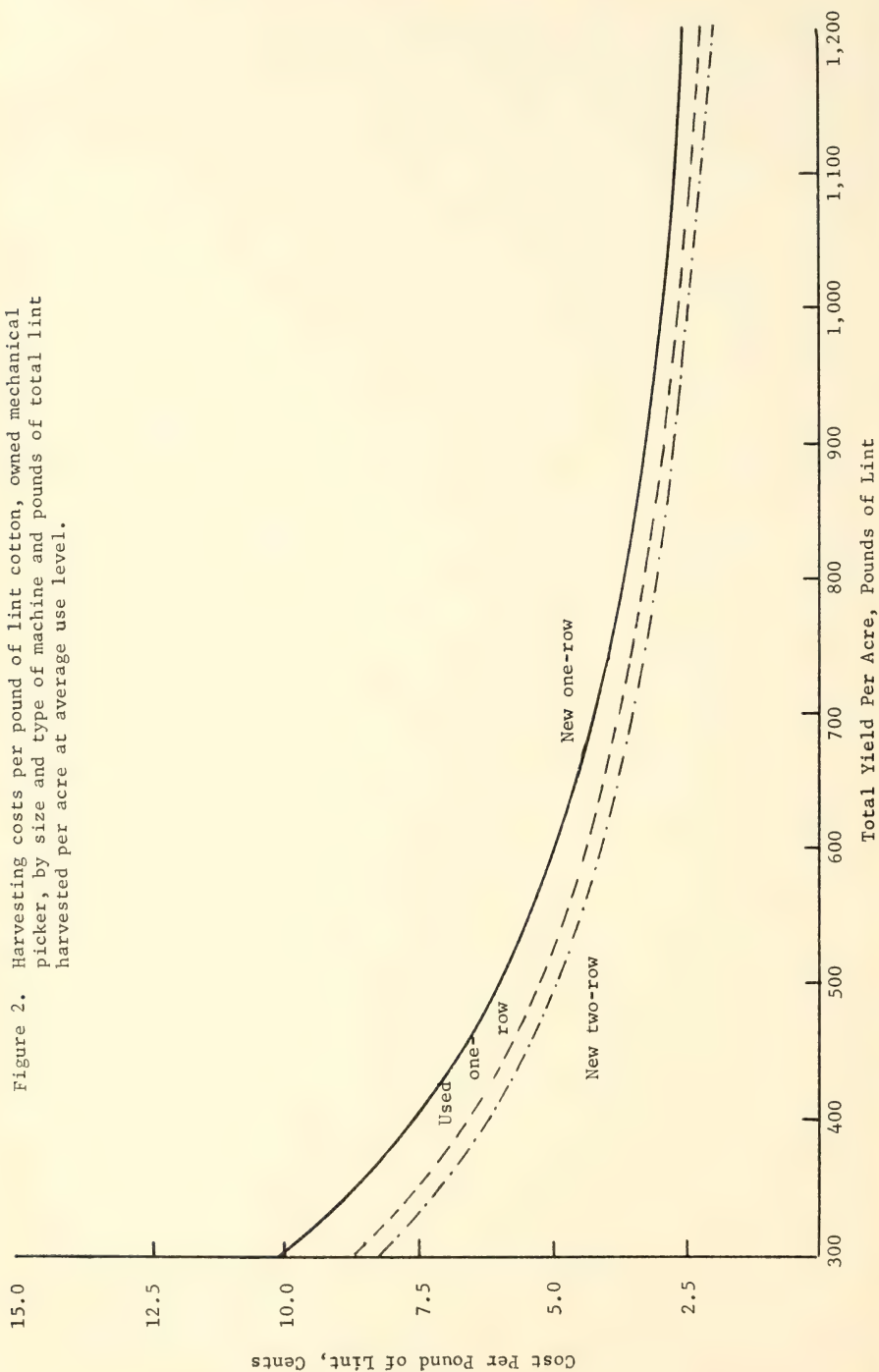
The extremes in total acres harvested are shown to illustrate the effect on per unit harvesting costs resulting from restricted and extended machine use under both low and high yield levels.

Mechanical picking costs decrease as (1) acres harvested increases and (2) pounds of lint harvested from a fixed acreage increases. The former reflects the spreading of fixed costs over additional acres and the latter reflects the spreading of both fixed and operating costs over higher yield increments of lint. Several important points can be drawn from these tables: (1) At "Low Use Ratings" the used one-row machine provides the cheapest means of mechanically harvesting cotton, even when yields are extremely high. (2) At "High Use Ratings" there is little difference in harvesting costs between a new two-row and used one-row machine when yields range from 300 to 600 pounds of lint per acre, and no difference when yields exceed 700 pounds of lint per acre.

The harvesting cost data in appendix tables 4 through 6 were used to construct the per unit cost curves in figures 1 and 2. They illustrate how the increasing yield affects mechanical har-

⁷One-row machine 1.33 hours per acre, two-row machine 0.75 hours per acre, once-over.

Figure 2. Harvesting costs per pound of lint cotton, owned mechanical picker, by size and type of machine and pounds of total lint harvested per acre at average use level.



vesting cost at various levels of use.⁸ When machine use is restricted, as in figure 1, a used one-row machine provides the cheapest harvesting cost regardless of yield harvested. The used one-row machine still provides the cheapest harvesting cost per unit even when the rate of use is increased to a normal or average level, figure 2. However, the difference in harvesting cost per pound of lint between a new two-row and a used one-row machine is very small; less than one-half cent per pound

when total expected yield is 300 pounds and becomes even less as yield increases.

Figures 3 and 4 illustrate the effect of increasing machine use while maintaining a constant harvesting level. As use increases, the point of intersection between two-row harvesting costs and used one-row harvesting costs moves to the left, and costs for the two-row machines beyond this point are less than those for a used one-row machine as yield increments increase.

SELECTING AMONG HARVESTING ALTERNATIVES

Every Delta cotton farmer is faced with the problem of selecting from several alternatives a harvesting method that best fits his individual situation. First, harvesting costs in either pounds of lint or seed cotton must be obtained for each alternative to be considered. Once this is done combinations of alternatives which the individual could use should be evaluated to ascertain which alternative or alternative combination provides the cheapest harvesting cost for the total crop.

The following information is required if an individual is to properly evaluate the harvesting alternatives and arrive at a reasonable cotton harvesting cost for his situation. For any owned machine he must:

(1) List range in expected machine use in acres.⁹

(2) Determine per acre harvesting cost for all owned machine alternatives covering the range of expected use.

(3) Estimate expected yield levels.¹⁰

(4) Determine harvesting cost per production unit at each expected yield level and use rate. List in tabular form as in appendix table 6.

Figure 5 illustrates graphically how the cost associated with the several cot-

ton harvesting alternatives would appear for an individual farm situation. Custom harvesting cost per hundred pounds of lint cotton is not affected by variations in yields or acres covered. The solid straight line in figure 5 represents this cost. Hand harvesting costs vary with yield but are not affected by the number of acres covered. The broken straight line in figure 5 represents three levels of hand harvesting (200, 500, and 900 pounds) using a 15-man crew and with out-of-pocket pay rate of \$2.50 per hundredweight of seed cotton.

Owned machine harvesting costs are easily obtained from figure 5. Only two alternatives are shown, used one-row and new two-row machines. The acres covered by each machine is multiplied by its performance rate since use is shown in hours. Harvesting costs per pound of lint for each owned machine alternative are found by (1) determining the total hours of use, (2) locating this point on the graph (figure 5), and (3) moving vertically from this point until the proper expected yield cost curve is intersected.

Two sets of harvesting cost curves are shown for the owned machine alterna-

⁸Use is measured in hours with each increment representing the use rate levels shown in appendix tables 1 through 3.

⁹Under most conditions extremes in use levels and expected yields need not be as great as those used in this report.

¹⁰Ibid.

Figure 3. Harvesting costs per pound of lint, owned mechanical cottonpickers by size and condition of machine and hours of use, at 500-pound total lint yield per acre, twice over picking.

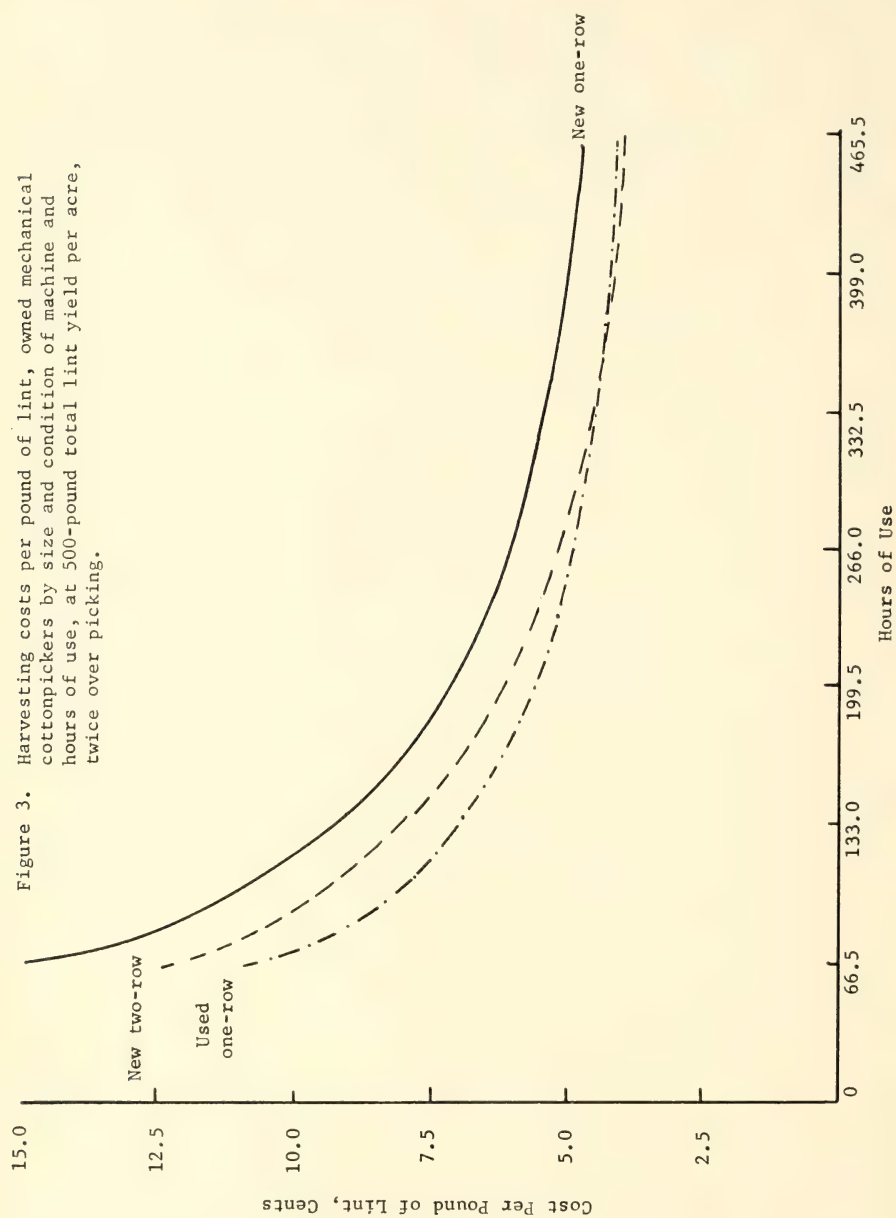
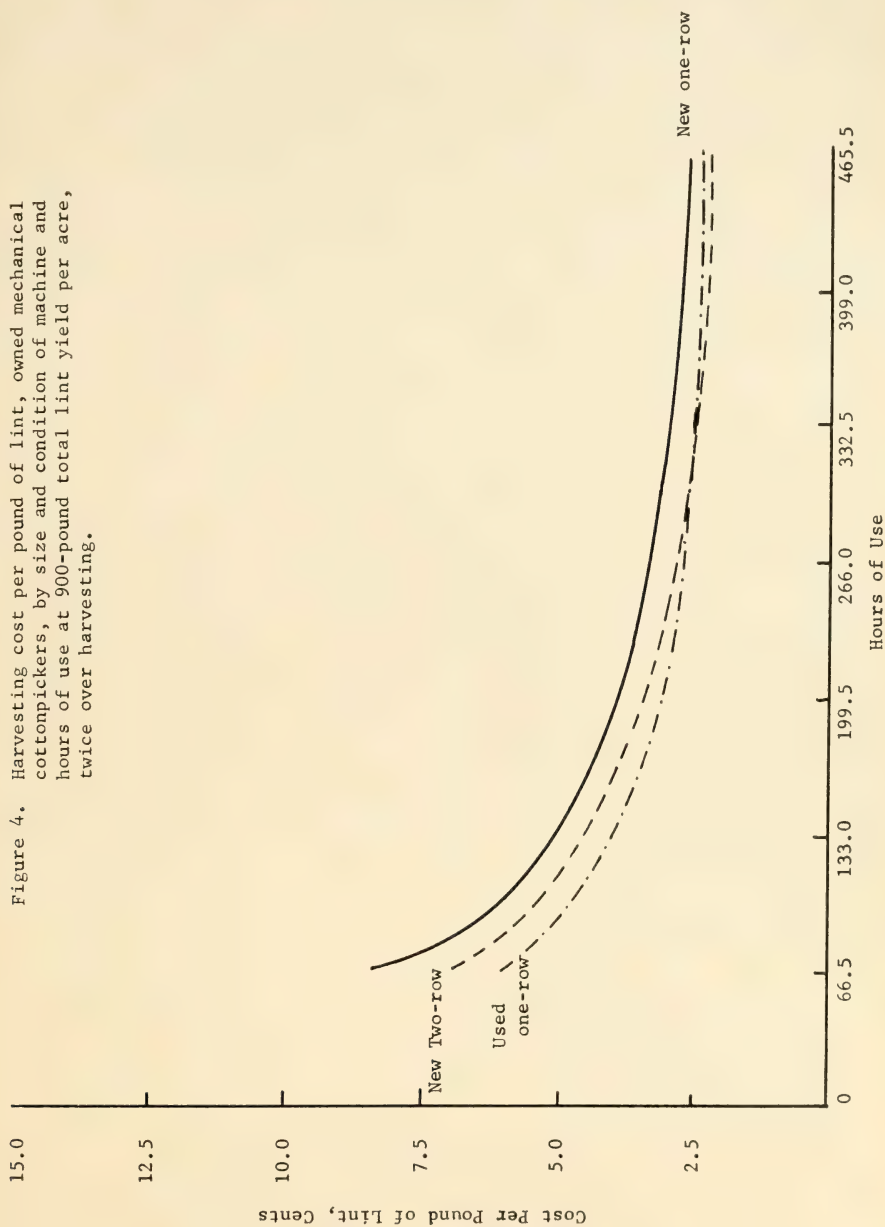
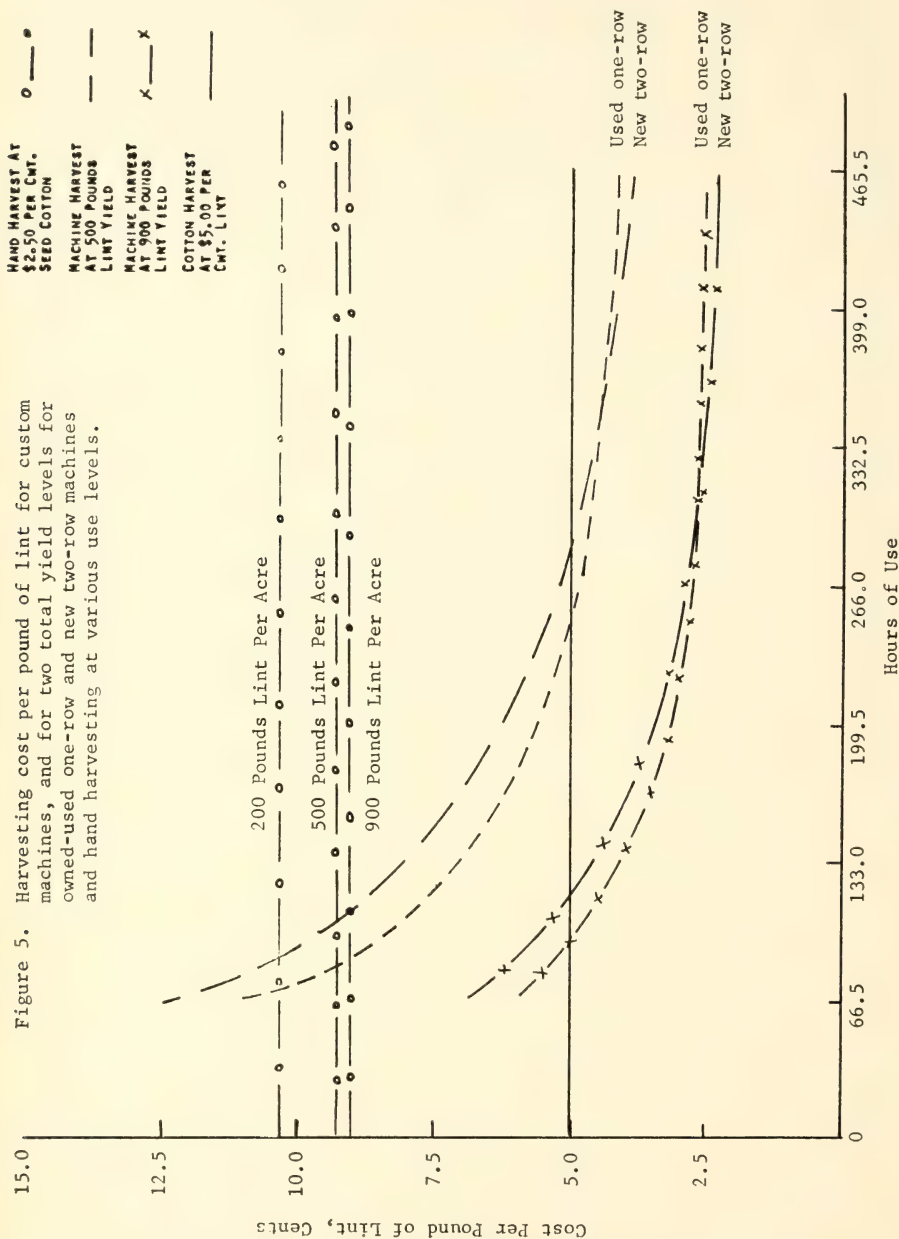


Figure 4. Harvesting cost per pound of lint, owned mechanical cottonpickers, by size and condition of machine and hours of use at 900-pound total lint yield per acre, twice over harvesting.





tives. The broken line curves are for harvesting costs at a 500-pound lint yield level and the broken-X- line curves indicate harvesting costs at a 900-pound lint yield. Cost curves for hand harvesting at three levels with a 15-man crew and custom machine harvesting are shown in figure 5. These curves illustrate the effect of yield variation on harvesting costs for each of the three major harvesting alternatives. In addition, harvesting costs per pound of lint can be calculated for any combination of harvesting alternatives.

For example, suppose farmer X has 135 acres of cotton and expects to harvest 500 pounds of lint per acre. He doesn't own a mechanical picker but is interested in harvesting the crop as cheaply as possible and in a reasonable length of time. A 15-man hand harvest crew is available and will pick for \$2.50 per hundredweight of seed cotton. Custom mechanical harvesting is also available at \$.05 per pound of lint. Owned machine costs are assumed to be those shown in appendix tables 2 and 3.

Farmer X decides to consider the following alternatives: (a) Harvest all of the crop by one method. (b) Hand harvest 200 pounds of lint per acre and harvest the balance with the cheapest mechanical alternative. (c) Custom harvest 100 acres and harvest the balance with the cheapest alternative.

Table 6 presents the costs for the various harvesting methods under each alternative considered by farmer X. Cotton harvesting costs were read directly from figure 5 and then converted into per acre and total harvesting costs. In section A, where any method can be used to harvest the entire crop, owned machines are the best choice, and the used one-row machine has the lowest per unit and total harvesting cost. However, it should be pointed out that at this use level the one-row machine is being

used almost at peak capacity while the two-row machine still has a considerable amount of useful capacity left.

When 200 pounds of the total cotton crop is hand harvested as shown in section B, the lowest cost machine alternative is custom mechanical harvesting. If a used one-row owned machine was selected, costs would increase about \$6.80 per acre; and a two-row machine would increase the cost per acre an additional \$10.00.

Harvesting costs for the owned machine alternatives may be reduced by picking the balance of the crop at one time. The adjustment in total harvesting cost reflects the reduction in total operating cost per acre; from \$14.78 to \$7.39 for the one-row machine and from \$11.62 to \$5.81 for the two-row machine. The fixed costs associated with both owned machine alternatives are not affected by the reduction in the number of pickings.

Such a decision would reduce total harvesting costs for the owned one- and two-row machine alternatives to \$1,954 and \$3,333, respectively. In this situation, there is little difference in the total harvesting cost when either the used one-row machine or the custom machine alternative is used in conjunction with hand harvesting.

If a large portion of the crop is custom harvested as shown in section C, the used one-row picker provides the cheapest alternative for harvesting the balance of the crop. If a two-row machine were used, the harvesting cost would increase about \$13 per acre for the acreage not custom harvested.

If expected yield were increased to 900 pounds farmer X would have to re-evaluate the harvesting alternatives being considered. Harvesting cost per pound of lint for both owned machine alternatives decreased as the expected yield level increases, figure 5. However,

Table 6. Total harvesting cost for a 135-acre cotton allotment by specific harvesting alternatives and method of harvesting with a 500-pound expected yield.

Item	Harvesting alternatives									
	A					B				
	Method of harvest					Method of harvest				
	One-row used	Two-row new	Custom machine	Hand	One-row used	Two-row new	Custom machine	Hand ¹	One-row used	Two-row new
Acres picked ²	135	135	135	135	135	135	135	135	85	85
Hours of use	359	205	---	---	359	205	---	---	326	127
Yield per acre	500	500	500	500	3	3	300	200	500	500
Cost per hundred pounds lint	4.38	6.10	5.00	9.30	4.38	6.10	5.00	10.40	4.50	7.15
Cost per acre	21.90	30.50	25.00	46.50	21.90	30.50	15.00	20.80	22.50	35.75
Alternative harvesting cost	2,956	4,118	3,375	6,278	2,956	4,118	2,025	2,808	1,912	3,039
Total harvesting cost	2,956	4,118	3,375	6,278	5,764	6,926	4,833		3,162	4,289

¹Harvested in single operation.²Picked twice over.³Owned machine cost per acre remains constant unless the number of times over or acres covered is changed.

total and per acre harvesting costs remain the same since the acres harvested and number of times picked were not changed. Custom machine harvesting is performed on a fixed cost per harvesting unit basis, and increases in yield results in an increase in per acre and total harvesting costs. Hand harvesting costs per unit tend to decrease slightly as yield increases, but per acre and total harvesting costs increase as yield levels rise.

In this situation farmer X would use the same combination of harvesting methods as indicated in table 6 for alternatives A and C. However, for alternative B both of the owned machine alternatives replace custom harvesting as the cheapest alternative for picking that portion of the crop not hand harvested, with the use one-row machine being the cheapest alternative followed by the new two-row machine.

If the cotton acreage were increased to 175 acres and the remainder of the assumptions are unchanged, farmer X would use the combinations of harvesting methods discussed in the above paragraph. Decreases in per acre harvesting costs ranged from \$1.30 to \$4.25 for the owned machine alternatives. The per

acre costs associated with custom machine and hand harvesting are not affected by an increase in acreage. Total harvesting costs for every harvesting alternative included in the analysis increased. However, the percentage increase in total cost was considerably less for both owned machine alternatives than that incurred by either custom machine or hand harvesting.

The correct harvesting alternative is determined in a different manner when farmer X owns a mechanical picker. Again, harvesting costs per unit must be obtained for each alternative. However, for the machine presently on the farm the capital investment has already been made and the machine will be used as long as the returns from its use exceed its operating cost. Thus, its per acre harvesting costs consist of operating costs only.

Farmer X would use the machine presently on the farm as intensively as possible since the total harvesting cost per acre is extremely low. He would consider no other harvesting alternative unless its total cost per acre was lower than the operating cost of the owned machine or the acres to be harvested exceed the physical capacity of the owned machine.

Appendix Table 1. Cost per acre twice-over harvesting with varying amounts of use, new one-row mechanical cottonpicker.¹

Acres picked ²	Use rating	Depreciation ³	Interest ⁴	Repairs ⁵	Operation ⁶	Total
Acres		Dollars	Dollars	Dollars	Dollars	Dollars
25	Poor	44.52	17.04	9.18	5.60	76.34
50	Low	22.26	8.52	9.18	5.60	45.56
75	Fair	14.84	5.68	9.18	5.60	35.30
100	Average	11.12	4.24	9.18	5.60	30.14
125	High	9.90	3.42	9.18	5.60	28.10
150	Excellent	7.42	2.84	9.18	5.60	25.04
175	Maximum	6.32	2.44	9.18	5.60	23.54

¹Cost items derived from data presented in Bulletin 667, "An Economic Analysis of Custom Work on Farms in the Yazoo-Mississippi Delta," June 1963.

²Twice-over picking.

³Based on 12 years of life expectancy for \$12,100 machine, and 20 years of life on three, three bale trailers valued at \$2,100.

⁴Based on 6 percent interest on the average investment.

⁵Based on repairs at 80 percent of new cost over life of machine and cotton trailers.

⁶Operational cost of fuel, oil, grease, operator labor, helper labor, tractor, hauling, etc.

Appendix Table 2. Cost per acre twice-over harvesting, with varying amounts of use, second hand, one-row mechanical cottonpicker.¹

Acres picked ²	Use rating	Deprecia- tion ³	Interest ⁴	Repairs ⁵	Operation ⁶	Total
Acres		Dollars	Dollars	Dollars	Dollars	Dollars
25	Poor	32.20	7.56	9.18	5.60	54.54
50	Low	16.10	3.78	9.18	5.60	34.66
75	Fair	10.74	4.67	9.18	5.60	30.19
100	Average	8.04	1.88	9.18	5.60	24.70
125	High	6.44	1.52	9.18	5.60	22.74
150	Excellent	5.36	1.26	9.18	5.60	21.40
175	Maximum	4.60	1.08	9.18	5.60	20.46

¹Cost items derived from data presented in Bulletin 667, "An Economic Analysis of Custom Work on Farms in the Yazoo-Mississippi Delta," June 1963.

²Twice-over picking.

³Based on 6 years of life expectancy for \$4,200 machine, and 20 years of life on three, three bale trailers valued at \$2,100.

⁴Based on 6 percent interest on the average investment.

⁵Based on repairs at 115 percent of new cost over life of machine, and 80 percent of new-cost¹ over life of trailers.

⁶Operational costs of fuel, oil, grease, operator labor, helper labor, tractor, hauling, etc.

Appendix Table 3. Cost per acre twice-over harvesting, with varying amounts of use, new two-row mechanical cottonpicker.¹

Acres picked ²	Use rating	Deprecia- tion ³	Interest ⁴	Repairs ⁵	Operation ⁶	Total
		Dollars	Dollars	Dollars	Dollars	Dollars
50.0	Poor	35.04	15.50	7.52	4.10	62.16
87.5	Low	20.02	8.86	7.52	4.10	40.50
135.0	Fair	12.98	5.80	7.52	4.10	30.40
175.0	Average	10.02	4.42	7.52	4.10	26.06
225.0	High	7.80	3.50	7.52	4.10	22.92
262.5	Excellent	6.68	2.96	7.52	4.10	21.26
300.0	Maximum	5.84	2.56	7.52	4.10	20.02

¹Cost items derived from data presented in Bulletin 667, "An Economic Analysis of Custom Work on Farms in the Yazoo-Mississippi Delta," June 1963.

²Twice-over picking.

³Based on 12 years of life expectancy for a \$18,500 machine, and 20 years of life on six, three bale trainers valued at \$4,200.

⁴Based on 6 percent interest on the average investment.

⁵Based on repairs at 80 percent of new cost over life of machine and cotton trailers.

⁶Operational costs of fuel, oil, grease, operator labor, helper labor, tractor, hauling, etc.

Appendix Table 4. Mechanical picking costs per pound of lint by acres harvested and lint yield per acre, new one-row cottonpicker.

Lint yield per acre	Acres harvested ¹						
	25	50	75	100	125	150	175
	Cents	Cents	Cents	Cents	Cents	Cents	Cents
300	25.45	15.19	11.77	10.08	9.03	8.35	7.86
400	19.08	11.39	8.82	7.56	6.77	6.26	5.89
500	15.27	9.11	7.06	6.05	5.42	5.01	4.72
600	12.72	7.59	5.88	5.04	4.52	4.17	3.93
700	10.91	6.59	5.04	4.32	3.87	3.58	3.37
800	9.54	5.69	4.41	3.78	3.39	3.13	2.95
900	8.48	5.06	3.92	3.36	3.01	2.78	2.62
1,000	7.63	4.56	3.53	3.02	2.71	2.50	2.36
1,100	6.94	4.14	3.21	2.75	2.46	2.28	2.14
1,200	6.36	3.80	2.94	2.52	2.26	2.09	1.96

¹Twice-over picking.

Appendix Table 5. Mechanical picking costs per pound of lint, by acres harvested, second hand, one-row cottonpicker.

Lint yield per acre	Acres harvested ¹						
	25	50	75	100	125	150	175
	Cents	Cents	Cents	Cents	Cents	Cents	Cents
300	18.18	11.55	9.35	8.23	7.58	7.13	6.82
400	13.63	8.66	7.01	6.17	5.68	5.35	5.11
500	10.91	6.93	5.61	4.94	4.55	4.28	4.09
600	9.09	5.78	4.67	4.12	3.79	3.57	3.41
700	7.79	4.95	4.01	3.53	3.25	3.06	2.92
800	6.82	4.33	3.51	3.09	2.84	2.67	2.56
900	6.06	3.85	3.12	2.74	2.53	2.38	2.27
1,000	5.45	3.47	2.80	2.47	2.27	2.14	2.05
1,100	4.96	3.15	2.55	2.24	2.07	1.94	1.86
1,200	4.55	2.89	2.34	2.06	1.89	1.78	1.70

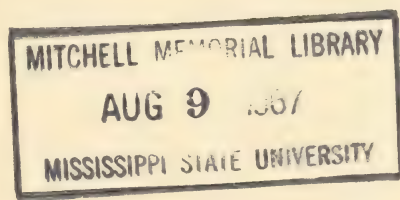
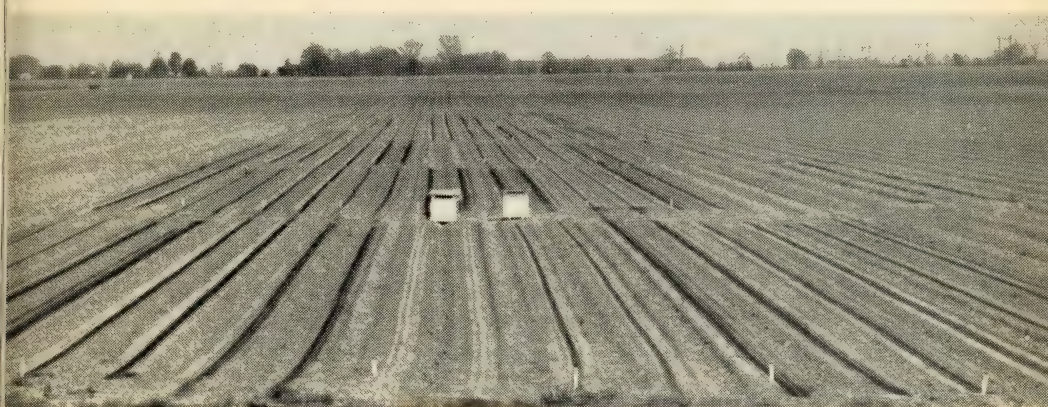
¹Twice-over picking.

Appendix Table 6. Mechanical picking costs per pound of lint, by acres harvested and lint yield per acre, two-row cottonpicker.

Lint yield per acre	Acres harvested ¹						
	50.0	87.5	135.0	175.0	225.0	262.5	300.0
	Cents	Cents	Cents	Cents	Cents	Cents	Cents
300	20.72	13.50	10.13	8.69	7.64	7.09	6.67
400	15.54	10.12	7.60	6.51	5.73	5.31	5.00
500	12.43	8.10	6.09	5.21	4.58	4.25	4.00
600	10.36	6.75	5.07	4.34	3.82	3.54	3.34
700	8.88	5.78	4.34	3.72	3.27	3.04	2.86
800	7.77	5.06	3.80	3.26	2.86	2.66	2.50
900	6.91	4.50	3.38	2.90	2.55	2.36	2.22
1,000	6.22	4.05	3.04	2.61	2.29	2.13	2.00
1,100	5.65	3.68	2.76	2.37	2.08	1.93	1.82
1,200	5.18	3.37	2.53	2.17	1.91	1.77	1.67

¹Twice-over picking.

Effects Of Petroleum Mulch On Growth And Yield Of Cotton



Mississippi State University
AGRICULTURAL EXPERIMENT STATION

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STATE COLLEGE

MISSISSIPPI

CONCLUSIONS

Studies over a 3-year period indicate that the use of a black petroleum resin mulch consistently increases soil temperatures in the zone of seed germination and emergence. The improvement in environment for seed germination and early seedling growth contributed to the significant improvement in plant stands obtained from this treatment.

Studies conducted in 1963 indicated that with mulch bands 6 inches wide, the soil temperature was maximum with a 25-gallon-per-acre application rate. Narrower bands, regardless of rate, were less effective. In 1963 significant increases in yields were obtained only from a 6-inch band application of mulch.

One of the most serious problems encountered in working with the petroleum mulch was obtaining effective weed control under the mulched area. Of the different herbicides evaluated, only a soil-incorporated application of trifluralin gave effective weed control in the mulch bands.

In plantings with widely spaced hills, mulch rates may be reduced by using spot application techniques. A 9-gallon-per-acre rate, applied in 9-inch square spots over each hill, was effective in improving stands.

Mulch treatments were quite effective in reducing soil crusting following rains in the 1964 test.

In general, the use of a petroleum mulch seems to be a desirable practice. On the basis of 10 cents per pound for

seed cotton, an increase of \$77.40 was obtained from the best mulch treatment in the 1963 study. This is high return for material and equipment cost.

However, experience with handling, transfer, and application of this type of mulch is necessary to establish its value as a farm production practice. The viscous nature of the product means that transfer from shipping containers to application equipment is slow. Consequently, use of the mulch with the planting unit would slow down the planting operation considerably. Use of separate application equipment would increase the need for labor during the critical planting period.

In other published reports^{3,4}, where mulch was used, yields were increased only in very early plantings. With petroleum mulch costs of at least \$8.50 per acre, for the 25-gallon-per-acre rate, yield increases would need to be considerable to warrant general use. In areas where early planting is necessary, or where crusting problems are of frequent occurrence, the use of mulch could be economically feasible.

³Cochran, B. J., L. H. Wilkes, G. A. Niles, D. I. Dudley, and T. L. Thaxton. 1964. The effects of a petroleum mulch on the growth and development of cotton. Texas A. Exp. Sta. Progress Report 2312.

⁴Phillips, R. E. and R. E. Frans. 1965. Effect of petroleum mulch on growth and yield of cotton in eastern Arkansas. Ark. Ag. Exp. Sta. Bull. 699. 21 pp.

EFFECTS OF PETROLEUM MULCH ON GROWTH AND YIELD OF COTTON

By C. D. RANNEY, O. B. WOOTEN, F. E. FULGHAM, and J. S. HURSH¹

Mulches of various types have for many years been used in the production of high-income crops. While the benefits obtained from such treatments are desirable in cotton production, problems of application and cost of materials often exceed return. In 1962 the Humble Oil and Refining Company made available a specially formulated water emulsion formulation of petroleum resins² that could be sprayed on the soil to form a black mulch film.

Studies were initiated in 1962 at the Delta Branch Experiment Station to evaluate this material as a means of reducing seedling disease, and of increasing cotton growth, development and yield.

1962 Tests

The test was planted on April 19, in a randomized block design with six replications. The mulch was applied as a spray in a 6-inch band over the seed drill during the normal planting process by using a conventional bronze gear pump spray system. A single rate of 100 gallons per acre of mulch was applied in 6" bands using a single 65 degree fan nozzle, with an orifice capacity of 1.5 gallons per minute per row. Several planter-box fungicides were used with the mulch treatment in an effort to reduce seedling disease losses. A preemergence herbicide, 3-(3,4-dichlorophenyl) - 1, 1-dimethylurea (diuron) was applied immediately ahead of and placed underneath the petroleum mulch.

Soil temperatures were measured by thermometers placed 2 inches under the surface of the seedbed. Yield data were obtained as a single harvest using a spindle-type picker.

Results and Discussion, 1962: The mulch treatment alone was as effective as a planter-box fungicide in reducing stand losses (Table 1). With high soil temperatures in early May, PCNB alone (and also with the mulch treatment) was toxic to the developing cotton. This accounts in part for the low stands associated with the 15% PCNB fungicide treatment.

The rate of mulch used in this study is neither economically nor mechanically feasible for cotton production. But results obtained, and observations made on the stability of the mulch band, suggested that similar benefits might be obtained with lower mulch rates. The mulch treatment promoted weed growth. The diuron herbicide treatment gave excellent control of weeds on either side of the mulch band, but did not control weeds adequately in the band of soil covered by the mulch.

Readings at 9 a. m., 2 and 5 p. m. indicated that plantings receiving the

¹Plant Pathologist, Crops Research Division, Agricultural Engineers, Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture, and Advisory Agricultural Meteorologist, Weather Bureau Agricultural Service Office, Environmental Science Services Administration, U. S. Department of Commerce, in cooperation with the Delta Branch of the Mississippi Agricultural Experiment Station, Stoneville, Mississippi.

²Trade name ENCAP. Trade names are used in this publication solely to provide specific information. Mention of a trade name does not constitute endorsement by the U. S. Department of Agriculture or the U. S. Department of Commerce over other products of a similar nature not mentioned.

mulch treatment had soil temperatures 2° to 6° F. higher (at the 2-inch level) than the check plots.

1963 Tests

The 1963 test was planted on April 12, or approximately 2 weeks before normal for this area. The study was made to determine the effect of rate of application and band width of mulch on the emergence, final stand, uniformity of stand, and yield of cotton. Mulch rates and band widths were varied to give similar film densities. The mulch rates ranged from 8.5 to 100 gallons per acre banded on 40-inch rows. A conventional bronze gear pump was used to spray the mulch solution. Fan-pattern nozzles with a 65° spray angle were used. The 100-gallon rate used an orifice capacity

of 1.5 gallons per minute and the 8.5 gallon rate used an orifice capacity of .15 gallons per minute. Planting speed was 2.5 mph.

A multichannel temperature recorder was used to measure temperatures. As the capacity of the recorder was limited to 7 readings, only temperatures under the mid - range of mulch rates were measured. A preemergence herbicide treatment, diuron, was applied immediately ahead of and therefore underneath the mulch treatments. A randomized block design with six replications was used in this study.

Results and Discussion, 1963: All mulch treatments gave plant populations significantly higher than the check plantings (Table 2). However, no greater uni-

Table 1. Summary of study evaluating effects of petroleum mulch and 3 pounds per acre applications of several planter-box applied fungicides on stand and yield of cotton, 1962.

Treatment		Plants per acre ¹	Missing hills per acre ¹	Yield per acre, lbs. seed cotton ²
Mulch	Fungicide			
100 gals.	None	50,324**	464**	2,553
100 gals.	Maneb + (10 + 10%)	47,500*	289**	2,372
100 gals.	Captan + PCNB (10 + 10%)	45,918	374**	2,502
None	Maneb + PCNB (10 + 10%)	44,376	374**	2,482
None	Captan + PCNB (10 + 10%)	43,098	499**	2,392
None	None	41,926	1,078	2,452
None	PCNB (15%)	39,596	539**	2,342
100 gals.	PCNB (15%)	39,471	873	2,181

¹Asterisks denote treatments significantly better than the untreated check, single asterisk indicates significance at the 5% level, double asterisks indicate significance at the 1% level as measured by Duncan's New Multiple Range Test.

²Differences are not significant.

Table 2. Summary of study evaluating different petroleum mulch rates and band widths on stand and yield of cotton, 1963.

Treatment		Stand, plants/A			Hills/A ¹			Yield, lbs. seed cotton/A ²
Gals. mulch	Band width	4/27	5/4 ²	5/18 ²	4/27 ²	5/4	5/18	
0	---	15,665	16,662	19,529	5,693	5,693	6,316	2,750
100	6"	13,421	19,446*	24,142*	4,737*	6,524	6,399	3,447*
67	4"	18,408	23,061*	27,258*	5,983	6,607	6,814	3,062
50	6"	15,256	20,693*	27,715*	5,526	6,607	6,939	3,338*
33	4"	15,873	19,155*	24,931*	5,693	6,233	6,690	3,090
25	6"	16,995	20,070*	26,718*	5,236	6,316	6,981	3,524*
17	4"	14,876	18,158	24,516*	5,983	6,441	6,898	3,151
12.5	6"	12,216	17,369	22,480*	4,778*	6,067	6,607	2,950
8.5	4"	18,158	17,660	22,687*	5,734	5,942	6,399	3,062

¹Perfect stand would be 7,665 hills.

²Asterisks denote treatments significantly different from the untreated check at the .05 level as measured by Duncan's New Multiple Range Test.

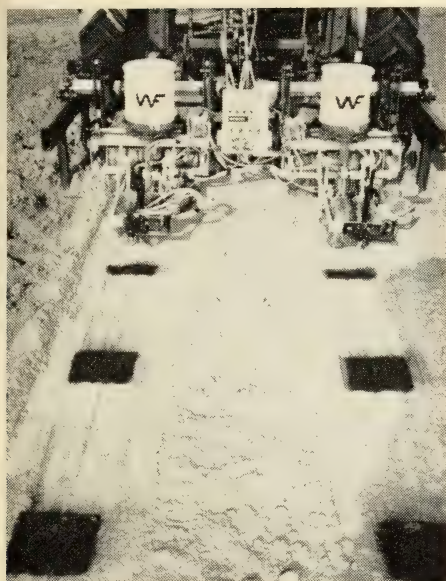


Figure 1. Research planter using cam-operated switches to synchronize hill-drop placement of seed and spot application of a petroleum mulch.

formity of stand, as measured by hills per acre, was obtained from any of the mulch treatments. Stand evaluations showed little difference among the various mulch treatments, either in gallons per acre or band width. When yield is considered, striking differences become apparent. Band width was a major factor in yield response. A 6-inch band resulted in yield increases that were not present with the narrow 4-inch band. Yield data, as well as all the stand data, indicate that as much benefit was obtained from 25 gallons per acre as from any of the higher rates.

Temperature data were evaluated for an 8-day period from April 16-23, 1963. Except for cloudy skies and .10 inch of rain during one day, weather conditions were generally clear to partly cloudy, with moderate winds. A summary of the effect of mulch rates on soil temperature is presented in Figure 2. The rela-

tive high temperature recorded under the 50-gallon-per-acre rate was undoubtedly due to the slope of the seedbed surface. Rows were orientated east to west; and because of a damaged planter presswheel, a slight southerly slope, about 25° downward for three-fourths of an inch, was formed over the seed drill. Although this may seem to be a slight deviation from the flat seedbed in the other treatments, the slight "profile" exposed to the sun resulted in daytime soil temperatures 2 to 3° F. higher than in any other mulch treatment. Damage to the planter presswheel was corrected after one replication (that in which temperature readings were made) of the 50 gallon-per-acre rate was planted.

Application of 17 gallons of mulch on a 4-inch band and 25 gallons on a 6-inch band resulted in mulch films of equal density. Hence, difference in response should be due to band width alone. A study of the data for the 25-gallon rate versus the 17-gallon rate shows a slight (but not significant) benefit in stand for the 25-gallon rate. In yield and temperature the differences are much greater. The advantages of a wider band of equal density are apparent in the yield data, and to a lesser but definite extent in the temperature data. The 12.5 - gallon rate on a 6-inch band resulted in higher soil temperatures than the more dense 17-gallon rate on a 4-inch band. The temperature data presented are for daylight hours only. The cooling rate at night was the same for all treatments and variations in minimum temperature were slight.

The use of a preemergence herbicide treatment with diuron failed to give adequate weed control in the portion of row covered with the petroleum mulch.

1964 Tests

The 1964 test was planted on April 17 in a randomized block design with five replications. An effort to reduce

mulch costs and to achieve effective weed control seemed desirable to determine the feasibility of using petroleum mulch in cotton production. A study using two different mulch patterns and rates, combined with three different herbicide treatments, was made in 1964. The different mulching patterns (one was a 6-inch wide continuous band, and the other was a 9-inch square spot centered over hills 36 inches apart) required 25 and 9 gallons of mulch per acre respectively.

A research planter was designed to synchronize a sprayed spot of mulch over the hill-planted cottonseed, figure 1. Electrical switches, which were actuated by single-lobe cams, controlled a compressed air system. Miniature air cylin-

ders operated the planter hill-drop valve and a quick opening valve mounted in the discharge line of each mulch spray nozzle. Cam lengths and placement controlled the opening of the hill-drop valve and the length and spacing of the sprayed spots. The nozzle valve was placed in the open position to apply the continuous band treatments.

These two methods gave mulch films of equal density but with different areas and continuity. A planter-box fungicide treatment, 3 pounds per acre of 10% PCNB-10% captan, was used in all plantings. Preemergence herbicide treatments of 2,4-bis(isopropylamino)-6-methylmercapto-s-triazine (prometryne) and a,a,a-trifluoro-2,6-dinitro-N,N-dipropyl-p-tolui-

EFFECT OF PETROLEUM MULCH ON SOIL TEMPERATURE

APRIL 16-23, 1963

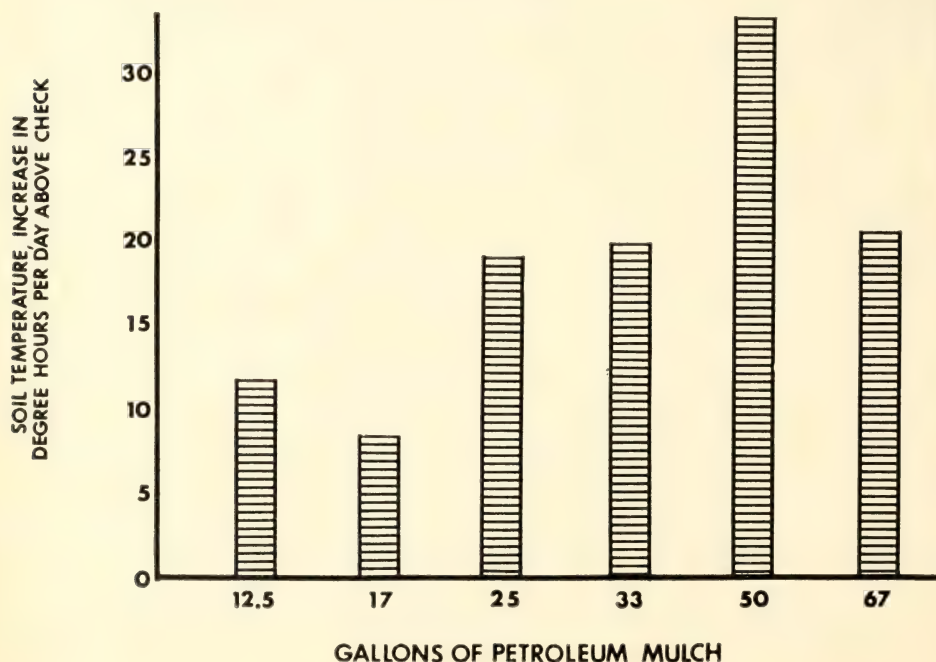


Figure 2. Effect of different rates of petroleum mulch on soil temperatures at the 2-inch level.



Figure 3. Cotton emerging through spot and band applications of mulch. With a soil-incorporated treatment with trifluralin, effective weed control was obtained under the mulch.

dine (trifluralin) were applied in bands 20 inches wide and incorporated into the seedbed with a commercial soil tiller.

Thermistors were placed 2 inches under the center of the seed drill to record temperatures on a multichannel recorder.

In each test, seed were planted $1\frac{1}{4}$ inches deep in moist soil of preformed beds.

Results and Discussion, 1964. The effects of mulch and herbicide treatments on plant population, stand, and weed control are summarized in Table 3. Early planting combined with very adverse environmental conditions resulted in severe seedling disease losses. Mulch treatments were effective in reducing stand loss. Soil crusting was greatly reduced where mulch was applied. The most encouraging result was the weed control

obtained in the mulch-treated areas where the herbicide trifluralin was used. This was the first effective weed control obtained with preemergence herbicides where mulch was used, Figure 3.

Temperature studies, summarized in Table 4, illustrate the effectiveness of the mulch treatments in increasing soil temperatures. During the interval from April 22 to April 27, 5.53 inches of rain were recorded. The temperature data recorded after the heavy rainfall occurred serve to illustrate the durability and effectiveness of the mulch treatment. The rain came as heavy downpours totaling 1.47 inches on the 22nd, 1.04 inches on the 25th, and 3.02 inches on the 26th. This heavy rainfall reduced the mulch's effectiveness, as measured by ability to increase soil temperatures, but the band treatment remained 86 percent effective. The spot treatment remained 69 percent

effective. Following this rainy period soil surfaces on untreated plantings and untreated areas between spot application developed a severe crusting problem.

However, mulched areas, free from the crust, were readily penetrated by cotton seedlings and in some cases by weeds

Table 3. Summary of study evaluating two methods of applying petroleum mulch in combination with two different preemergence herbicides on seedling disease and weed control, 1964.

Mulch	Method	Treatment		Lbs./A ²	Stand ¹		% freedom of weeds ⁴
		Gals./A	Herbicide		Plants/A	Hills/A ³	
None		---	None	---	12,450abcd	3,409 c	38
None		---	Prometryne	1.25	9,600 cd	3,557abc	90
None		---	Trifluralin	0.62	8,850 d	3,758abc	99
Yes	6" band	25	Prometryne	1.25	15,200a	4,158a	72
Yes	6" band	25	Trifluralin	0.62	12,650abc	4,058abc	98
Yes	9" spot	9	Prometryne	1.25	11,750abcd	3,758abc	76
Yes	9" spot	9	Trifluralin	0.62	14,400ab	4,108ab	98

¹Plant population per acre, 40-inch rows. Means followed by same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

²Band rate, not broadcast.

³A perfect stand would be 4,356 hills.

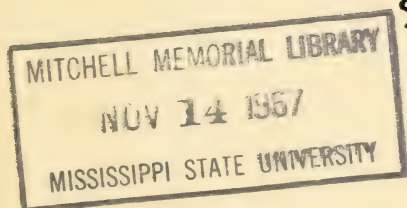
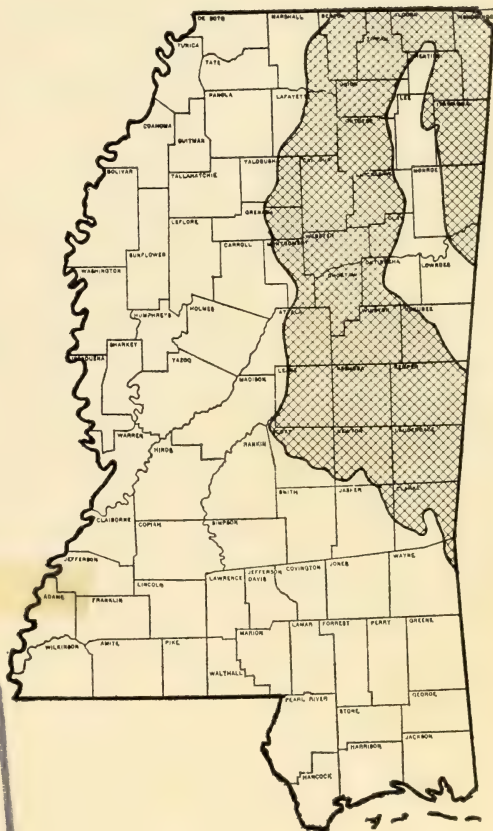
⁴Annual grasses.

Table 4. Comparisons of soil temperatures, at the 2-inch level, under petroleum mulches before and after 5.53 inches of rain. Delta Branch Experiment Station, Stoneville, Miss., April 18-May 5, 1964

Comparison	Mulch treatment					
	April 18-21			April 29-May 5		
	Band	Spot	None	Band	Spot	None
Average 24-hr. temperature, ° F.	72.16	71.84	71.35	70.47	70.20	69.94
Increase above check, ° F.	.81	.49	---	.54	.26	---
Degree hours per day above a 65° F. base	171.84	164.16	152.40	131.28	124.80	118.56
Increase of degree hours per day above check	19.44	11.76	---	12.72	6.24	---
Percent increase	12.76	7.72	---	10.73	5.26	---

Employment Opportunities in Farming With Varying Levels of Income In The Sand-Clay Hills of Mississippi

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SUMMARY

A number of crops and livestock combinations that will yield specified income levels exist for farms in a given area. Some combinations are more efficient in the use of resources than others.

This study was undertaken to determine the kinds and quantities of farm resources required to provide farm operators with specified levels of net money farm income¹ and to estimate the number of farm employment opportunities that may exist in the Clay-Hills with the resource requirements for specified levels of income. Organizations for each type of farm and situation were derived through budgeting by the mathematical technique of integer programming for twelve of the more realistic alternatives for income targets of \$3,000, \$4,000, \$5,000 and \$8,000.

Resource requirements to earn a specified net money farm income under alternative situations and organization of farms varied widely. At the \$3,000 income level the land resource requirement ranged from 69.3 total acres for a Crop-and-Feeder-Pig operation where corn purchase was allowed to more than 400 total acres for a beef cow-calf operation; total labor requirement ranged from 1,065 hours to 2,362 hours; and capital investment from \$18,534 to \$69,652. At the higher income levels resource requirements for the different organization of farms showed even greater variation.

As the income target is raised the amount of land and other resources has to be increased proportionally more than income. Data are not presented on resource returns for incomes of less than \$3,000, but previous analyses suggest

that farm operators earning less than \$3,000 net money farm income could increase their total earnings with off-farm employment, if available, even at \$1.2 per hour. This is possible because farming at the \$3,000 level of net money farm income will usually provide less than full-time employment for the operator and the returns per hour employed on the farm are less than the minimum wage rate. However with advanced age and limited education many operators earning less than \$3,000 net money farm income are unable to make adjustment within the farm organization or work off the farm.

The number of farming opportunities in the Clay-Hills depends on the income target selected and the type of farm organization. Farm employment opportunities would decrease under any of the income levels selected. This would result because of the reduced need for seasonally hired workers. At the higher income levels the number of farm employment opportunities would be reduced drastically even on crop farms. With livestock farms, with or without crops, the reduction in farm job opportunities would be greater.

The estimated aggregate amount of capital needed to raise the incomes of all those farm operators in the area who are presently earning less than \$3,000 would range between \$200 and 350 million dollars depending on the enterprises selected. Investments in machinery and equipment would command the largest amount of funds but investments in land for farm enlargement would also be a large claimant. The livestock organizations would need relatively large amounts of operating capital.

¹Total farm cash receipts less total farm expenses.

EMPLOYMENT OPPORTUNITIES IN FARMING WITH VARYING LEVELS OF INCOME IN THE SAND-CLAY HILLS OF MISSISSIPPI

By JOHN C. CRECINK*

INTRODUCTION

In the last several decades off-farm employment in the Hill section of Mississippi has increased at the same time that substantial outmigration has occurred. Farm employment on the other hand has continued to decline and during 1965 manufacturing employment exceeded agricultural employment for the first time.¹ As a result of increased non-farm employment, substantial outmigration and a general nationwide improvement in economic conditions per capita income in the area has risen steadily during the last 25 years. In 1940 Mississippi's per capita income was only \$218 or less than three-eighths of the national per capita income, whereas in 1965 it was \$1,608 or almost three-fifths of the national level. However, Mississippi has had for many years and continues to have the lowest per capita income of any state in the nation.²

As more off-farm job opportunities are developed in the area and in the State, less reliance is placed upon agricultural production as the primary source of income. The value of agricultural production in the area has increased over the years but non-agricultural production has grown more rapidly. The number of farms in the area has decreased by more than half (52 percent) in the last 25 years as a result of farm enlargement and more off-farm job opportunities.

However, it must be recognized that the farm income problem cannot be solved by continually increasing the number of off-farm job opportunities in the area because many farm operators are "boxed in" and have neither the physical, the mental, nor the financial resources to take advantage of opportu-

nities that could increase their incomes. Additionally, the area after experiencing a net loss in population for some period of time because of out-migration is now experiencing population growth from some in-migration and a much lower out-migration rate. Consequently, the increase in new off-farm job opportunities in the area is at present only just keeping pace with the net new additions to the area labor force.

As a result, the opportunities for non-farm employment by the resident farm population are more limited than previously. It appears that in many local areas new plants and facilities have already siphoned off much, if not most, of the employable labor supply. Businesses locating in the area in the future will have to either entice prospective emigrants to remain in the area and thereby further increase the area's labor force, compete with present concerns for labor, or import at least part of their labor from

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¹Mississippi Employment Security Commission. "Mississippi Labor Market—Annual Supplement." Mississippi Labor Market, Monthly Review of Current Labor Force, Hours and Earnings, Labor Turnover, Research and Statistics Department, Miss. Employ. Secur. Comm., Jackson, Vol. XVII. No. 2, Suppl., March 1966.

²U.S. Department of Commerce. "Survey of Current Business." Vol. 46, No. 8, Table 2, Page 13. GPO, Washington, August 1966.

outside the area. The first of these could well be accomplished by changes in the hiring and advancement policies of prospective and presently located businesses and by a training and retraining program that could give reasonable assurances to trainees that job opportunities would be available at the completion of the prescribed schooling.

Still another factor that has retarded adjustments has been the location of plants and factories in the rural areas that limit employment almost exclusively to females. This practice increases labor force participation but tends to "freeze" the husbands in their present occupations, primarily farming inadequate sized units, and reduce further resource mobility. Much of the pressure on the farm operator to provide an adequate family income is relieved because of the off-farm earnings of the wife. Therefore, the economic pressure on the farm operator to make farm adjustments or to seek off-farm employment either locally or by migrating is lessened considerably.

One of the more pressing needs of the area is employment opportunities for the unemployed and underemployed males who for one reason or another are "tied" to the area. Providing these types of opportunities would help in the solution of the agricultural adjustment problem. However, prior research in the area indicated that a relatively large percentage of the farm families have limited adjustment potential, principally because of advanced age, physical disabilities, educational deficiencies and strong family ties.¹ Under these circumstances many operators have no alternative but to continue full-time farming, the thing they know and can do best.

Therefore, to increase these families' incomes above the poverty level will require either adjustments in resource use within the farm firm, or income transfers, or both.

An earlier report² investigated the

possibilities for improving farm incomes of present farms by adopting an improved level of technology. It was concluded with the present resources, incomes of most small and medium farms (these two groups represent nearly three-fourths of the farms in the area) could be increased, but not enough to raise their income levels to \$3,000 net money farm income, i.e., cash receipts minus cash expenses. To reach this level, most farms would have to be increased in size but increasing farm size in the area would reduce farm employment opportunities and contribute to the overall adjustment problem.

Objectives of This Study

The specific objectives of this study are: (1) to determine the kinds and amounts of resources required by different types of farms to enable farm operators to earn specified levels of net money farm income; and (2) to estimate the number of farming opportunities in the area subject to the resource requirements for the specified levels of net money farm income.

Methods and Procedures

Data sources and a generalized description of the procedures used in the present analysis are contained in previous reports from this same overall study.³ Procedures were modified to include income targets of \$3,000, \$4,000, \$5,000

¹This aspect of the adjustment problem is reported in detail in Crecink, John C., "Incomes, Resources, and Adjustment Potentials of Rural Families in the Clay-Hills Area of Mississippi." Miss. Agr. Expt. Sta., AEC M. R. No. 29, November 1960.

²Crecink, John C. and McLaughlin, Albert L. "Increasing Incomes of Farm Families Through Farm Adjustments, Clay-Hills of Mississippi." Miss. Agr. Expt. Sta., AEC. M. R. No. 44, March 1965.

³Crecink, John C., "Budgets for Major Farm Enterprises in the Clay-Hills of Mississippi." Miss. Agr. Expt. Sta., AEC. M. R. No. 45, March 1965, and Crecink, John C. and McLaughlin, Albert L., *Op. Cit.*, pp. 2-4.

and \$8,000 subject to a minimum land restriction, except with dairy enterprise analysis. Here the integer of a 50-cow milking herd was the restriction and no income targets were set. Resources required for farm incomes between \$1,000 and \$2,500 for the same type of farms used in this analysis can be approximated from the report by Crecink and Mc-

Laughlin cited above.

Integer linear programming techniques were used, to develop optimum enterprise combinations. However, the analysis centered around achieving a specified income level from a minimum land resource for each type of farm rather than maximizing net income from given resources.

RESOURCE REQUIREMENTS AND ENTERPRISE COMBINATIONS NECESSARY FOR SPECIFIED LEVELS OF NET MONEY FARM INCOMES

In any area or region there are a number of enterprise combinations that will yield specified income levels. Some enterprise combinations are more efficient in their overall use of resources than others. But a particular enterprise combination may be more efficient in the use of a specific resource and if the specific resource is in limited supply the limitation constitutes a restriction upon production. In the analysis that follows, open land is assumed to be a limiting factor and with this restriction the enterprise combinations presented are the most realistic choices for full-time farmers in the area.

Eleven organizations of farm enterprises for four levels of net money farm income are presented (Tables 1-11). The programmed farms represent seven basic types of organizations: cotton, cotton and feeder pigs, cotton and market hogs; cotton and beef cattle; feeder pigs; market hogs; and beef cattle. Each of the organizations that includes a swine enterprise is presented with two situations: (a) where corn or its equivalent for the swine enterprise is allowed to be purchased, designated throughout the remainder of the report as I; (b) where all corn or its equivalent for the swine enterprise must be produced on the farm, designated as II. Poultry and egg production in the area is almost entirely under contractual

arrangements where the farm operator supplies most of the facilities and his labor with the contractor furnishing the birds, feed, and management. Therefore, poultry operations are not considered as enterprise alternatives.

Earlier farm survey data established a close relationship between the acreage of open land in a farm and total size. The small and medium size of farms with less than 60 acres of open land had approximately .8 acres of woodland for each acre of open land. Large farms had approximately 1.3 acres of woodland for each acre of open land. These multipliers were used to estimate total farm size for the different organizations. As the larger farms had a proportionally larger acreage of woodlands than medium and small farms, a slightly lower value per acre was used to estimate the land of large farms.

It has been estimated that under good forest management net returns per acre of farm woodland would average between \$4.00 and \$6.00 per year depending upon site, specie, and location.⁴ Since a determination of the number of operators who can make these adjustments was not feasible as a part of this study, returns

⁴Williams, Robert L. and Hurt, Verner G., "An Economic Evaluation of Forestry Alternatives in the Yellow Creek Watershed," Miss. Agr. Exp. Sta. AEc. M. R. No. 41, June 1964.

from woodlands have not been included in net money farm income. Proper management of farm woodlots can result in increased returns to the farm operator but its contribution to net farm income is small compared with the crop and livestock enterprises.

\$3,000 Net Money Farm Income

The size of farm needed to earn \$3,000 net money farm income varies with the enterprise combination. The programmed levels of net money farm income are subject to two labor restrictions: first, all chop, pick and extra harvest labor is hired; and second, only the operator's labor is utilized. These restrictions on the use of the operator's labor results in greater underemployment than would normally be the case. The net money farm income of each of the programmed organizations would be increased if maximum utilization of the operator's labor was made. The amount of increase would be only a few dollars in the case of livestock farms but would amount to several hundred dollars in the case of the cotton farms.

The increase in net money farm income above the programmed levels due to greater utilization of the operator's labor by types of farm organizations are shown in Tables 1a through 10a. A summary of these is shown in Table 12. The possibility of substituting additional unpaid family labor for some hired labor also exists but the amount that can be substituted will vary from farm to farm; therefore, no estimates have been made of how much such a substitution could add to net cash farm income. It could range from nothing to several hundred dollars depending upon the type farm organization and the family labor supply.

A crop and feeder pig operation where corn purchase was allowed required only 69.3 acres of land (Table 2) whereas a beef cattle cow-calf operation required

more than 400 acres of land (Table 11). The farm organizations at the \$3,000 level of income are equivalent in size to the medium size of farm in the area.⁶ The more intensive hog enterprises generally, both feeder pigs and market hogs with and without other cash crop enterprises, required less total acreage for a given level of income than the general crop farm.

In each farm organization where cotton was allowed as an enterprise the full allotment was utilized and the land requirement was less than for corresponding organizations without cotton. Land requirements were less for the farm organizations with cotton and returns per acre of open land⁷ were greater in each instance (Tables 1-11). Thus cotton is an important enterprise in the area.

Returns per acre of open land ranged from a positive \$4.79 for the Crops and Market Hogs I⁸ organization to a negative \$3.64 for the Beef Cattle organization. Where it was possible to substitute operator's labor for hired labor, such as in those organizations having a cotton enterprise, returns were increased by as much as \$6.57 over the programmed level. For the livestock organizations the increase, if any, was small.

Labor requirements for the different organizations and situations varied from 1073 hours for the Feeder Pig II operation to 2330 hours for the Crops and Beef Cattle operation. Each of the organizations with cotton as an enterprise had

⁶See Crecink and McLaughlin, *op. cit.*

⁷Derived by subtracting \$2,400 for the operator's labor from returns to land, labor, and management, then dividing by the total acreage of open land in the farm.

⁸The Roman Numeral I following a type of farm organization indicates a situation where corn purchase is permitted. The Roman Numeral II following a type of farm organization indicates a situation where all feedstuff must be produced on the farm.

higher labor requirements than its counterpart without cotton. However, because of the seasonal demand for labor by the cotton enterprise, each of the programmed organizations with cotton included hired labor. Conversely, the operator could supply most of the labor where cotton was not an enterprise. Where maximum use of the operator's labor was made, only the Crops and the Crops and Beef-Cattle organization hired chop labor and in all probability the family could supply the small amount of additional chop labor needed in these two organizations. The percentage varied from a low of 22 percent for the Crops organization to a high of 100 percent for the Feeder Pigs I organization. Also, a low of 18 percent of the operator's labor would be used in the Crops organization and a high of 76 percent with the Beef Cattle organization.

Again, where it is possible to substitute operator's labor for hired labor the amount of labor supplied by the operator in some cases more than doubled. Under this condition, the operator supplied 55 percent of the labor for the Crops organization and 100 percent of the labor for the Feeder Pig I and II organization. This suggests that, even where maximum use of the operator's labor is made, a continued decline in the supply and an increase in the price of agricultural labor will result in a shift to those enterprises where the operators supply most of the labor if they are to maintain or raise their levels of income.

Farming, at the \$3,000 level of net money farm income, will usually provide less than full-time employment for the operator even where maximum use of the operator's labor is made. The degree of underemployment depends upon the farm organization. Where part time off-farm employment is available, the crops and the crops-beef cattle types of farm organizations will allow the operator the most time for off-farm employment if all chop, pick and extra harvest labor is hired. Otherwise, the hog enterprises where corn

purchase is permitted would allow more time.

Returns per hour of operator's labor on the farm were greatest on the crops farms and least on the beef cattle farms. However, returns per hour of available operator's labor (2080 hours) were highest to the Crops and Market Hogs I organization. Because of the possibility of substituting operator labor for hired labor in those organizations with cotton the returns per hour of available operator's labor are greater when maximum use of the operator's labor is made rather than as programmed. The highest rate of return accrued to the Crops organization under this condition, but all of the organizations with cotton showed returns above \$1.00 per hour available. At the \$3,000 net money farm income level the minimum wage rate exceeds the minimum level for all programmed organizations except Crops and Market Hogs I.

If full-time off-farm employment at or above the minimum wage rates were available, it would be advantageous for farm operators earning \$3,000 or less net money farm income to either seek off-farm employment, increase the on-farm use of their labor, attempt to increase the size of their operation, or a combination of these.

The capital investment, not including operating capital, necessary to earn \$3,000 net money income varied from a low of \$18,534 for the Crops and Feeder Pigs II organization to \$69,652 for the Beef Cattle organization.⁹ All except one of the organizations had a capital investment of less than \$30,000. Thus 10 of the 11 organizations needed less than \$10 capital investment per dollar of net money farm income. Based on current cost-price relationships, the Beef Cattle organization takes more resources to produce the specified level of net cash farm income. This

⁹Capital investment items, as used here, includes land and improvements, machinery and equipment, and livestock. Operating capital refers to funds necessary to cover current cash expenses.

amount of resources is not generally available to farmers in the area. However, since most commercial cattle operations in the area were begun when both land and livestock prices were much below current levels, the cash investment in most of them is considerably lower than programmed. Thus, interest on cash investment—the largest single expense item—is also sharply below, and net cash farm income is substantially above that shown.

Returns on the capital investment at the programmed \$3,000 level of net money farm income ranged from a minus 0.77 percent for the beef cattle organization to 1.35 percent for the crops and beef cattle organizations. Four of the eleven organizations showed a negative return on the capital investment at this level of income and all had a very low rate of return. In general small farms are over capitalized, particularly the small livestock farms that purchase most of their feed.

In summary, farms earning \$3,000 net money farm income are not large enough to use land, labor, or capital efficiently even with the best available practices and techniques. The majority of farms in the Hill section of the State earn less than \$3,000 and are smaller and thus, more inefficient in their use of resources than indicated by this analysis.

\$4,000 Net Money Farm Income

Increasing net money farm income from \$3,000 to \$4,000, for most (10 of the 11) organizations meant increasing farm size (in terms of land) between 30 and 40 percent but using the other factors more intensively. In each organization where corn purchase was permitted, the livestock enterprise also increased in size. In the two crop and livestock organizations where corn purchase was not permitted the livestock enterprise remained the same size as for the \$3,000 income farm but the additional income came from increas-

ed cotton production. In the case of the Market Hogs II organization, the livestock enterprise remained constant, but the additional revenue arose from corn sales.

The returns to the resources increased in each organization, except the Beef Cattle organization, as income was increased from \$3,000 to \$4,000. For example, the average net returns per acre of open land for all organizations increased from \$1.05 to \$12.28; average returns per hour of labor available rose from \$0.93 to \$1.28; and average returns per dollar of capital investment increased from 0.4 percent to 3.3 percent. With the exception of beef cattle organizations, more of the operator's labor was utilized on the farm at the higher income level. Since labor was more intensively used, the possibility of substituting operator labor for hired labor was not as great as in the organizations earning \$3,000. For most organizations, the family could probably supply the extra labor needed, except for the pick labor.

Total investment in the farm increased about one-third, or equal to the increase in income, with investment in land rising the most. The average investment in machinery, equipment, and facilities increased by less than 10 percent over the \$3,000 income level needs. The larger crop acreage of \$4,000 level income organizations could generally be handled with the same machinery and equipment as the \$3,000 income level organizations. The increase in the investment was generally restricted to facilities for the large hog enterprises.

The increased size of the \$4,000 income level organizations allowed for greater efficiency in the use of available resources but they are still too small to realize full economies of scale. This is particularly true for the operator's labor which averaged being employed only about 60 percent of the time even when maximum use of his labor was being made.

\$5,000 Net Money Farm Income

Increasing net money farm income from \$4,000 to \$5,000 necessitates an increase in acreage, livestock numbers, and, in most organizations, a larger investment in machinery and equipment in addition to an increased investment in facilities for the livestock enterprises. The latter results because the additional cropland acreage makes the use of a medium sized tractor necessary. With the lumpiness of the investment in machinery and equipment the additional investment in these items was proportionally more than the increase from \$4,000 to \$5,000 in income. However, average net returns to the various factors in each organization except Beef Cattle increased.

The farm acreage necessary for earnings of \$5,000 net money farm income are approximately equivalent to the average large size of farm in the area, with three exceptions. The exceptions are the Crops-and-Feeder Pigs I and II organizations which are only about one-third as large and the Beef Cattle organization which is about four times larger. The programmed returns per acre of open land average \$18.54, ranging from \$0.19 for Beef Cattle to \$27.80 for Crops and Feeder Pigs I.

The proportion of the operator's labor utilized decreased in five of the eleven organizations and was almost unchanged in another. This resulted from the use of the larger machinery and equipment which requires less time to cover the same acreage than does the smaller items used on the \$3,000 and the \$4,000 income level organizations. If maximum use is made of the operator's labor four of the organizations still showed a decrease in the proportion used. Because of the small amount of chop labor that is required to be hired, particularly in those organizations with swine enterprises, it is possible that the family could meet these labor needs. However, for those organizations

containing a cotton enterprise, it would be necessary to hire pick labor.

Because of the seasonality of the demand for labor most of the organizations offer only small possibilities for the substitution of operator's labor for hired labor. Therefore, the returns to the operator's labor is nearly the same, whether for programmed or substituted. Programmed returns to the operator's labor per hour available averaged \$1.56 overall (Beef Cattle organization excluded) with only a small variation among the enterprise combinations.

The largest percentage increases in investment, other than the Beef Cattle operation, occurred in the Crops, and Crops and Beef Cattle organizations. Land and, to a lesser extent, machinery and equipment were responsible for the increases. Total investment ranged from \$24,809 for the Crops and Feeder Pigs II organization to \$182,183 for the Beef Cattle organization. Returns per dollar invested averaged 4.7 percent, with the Crops and Feeder Pigs II organization yielding the highest, 7.7 percent. The Beef Cattle organization yielded no return on investment capital.

\$8,000 Net Money Farm Income

Farm organizations with the resources to produce \$8,000 net money farm income are considerably larger than the average size farm in the area. Increasing income from \$5,000 to \$8,000 involved increasing the acreage in farms by 60 percent for the Crop organizations to 132 percent for the Beef Cattle organization. It also required basic changes in the enterprise combinations. More of the corn requirement was farm-produced in each of the situation I organizations. Not only was more of the feed produced in these instances, but in two of the organizations, Feeder Pigs I and Market Hogs I, the livestock enterprise decreased. The extra income in these two organizations arose from the operators selling their own feedstuff in

the form of pigs and pork. Returns per acre of open land increased to an average of \$25.91 but varied from \$1.88 for the Beef Cattle operation to \$38.56 for the Crops and Feeder Pig I organization.

Labor requirements for the different organizations ranged from 1537 hours for the Market Hog II organization to 6,468 for the Beef Cattle organization. Generally, the Crop and Crop-Livestock farms had the highest labor requirements but did not make the greatest use of the operator's labor. Only about one-fourth of the operator's labor was utilized in the crops organization, although total labor required was 5,377 hours. Less than 50 percent of the operator's total labor is used if maximum utilization occurs. The possibility of substituting operator's labor for hired labor was generally less than at the lower income levels. Net money farm incomes could be increased from \$21 to \$303 depending on the farm organization. Returns to the operator's labor per hour available averaged \$2.40, exclusive of the Beef Cattle operation. For this income level and group of farms the returns varied a maximum of \$0.38 from the average.

The large total investment to achieve this income level was a reflection of the additional acreage needed rather than increased needs for machinery equipment and facilities, and livestock. In all organizations the increased land investment was more than 50 percent of the total investment. Yet returns on investment averaged 7.1 percent for all organizations and varied from just over 10 percent for the Crops and Feeder Pigs II organization to 0.5 percent for the Beef Cattle organization. Generally, the investment necessary per dollar of net money farm income for the different levels of income of a given organization varied slightly. Even among organizations the variation was small except for the Beef Cattle organizations.

All organizations with \$8,000 net money farm incomes had at least one and

one-half times more acres than their counterpart earning \$4,000. This difference is largely due to the larger proportion of woodland on the larger farms, but partly due to the additional pasture needed.

This analysis has not attempted to determine optimum size for each type of farm. There are indications that the optimum size for each particular farm type, except for the Beef Cattle farms, was not obtained even at the highest level of income. This indication stems from the fact that each of the net return figures rose as income levels rose, although, the rate of increase had begun to decline at the highest income level. This analysis has determined the present optimum enterprise combinations and resource requirements for specified levels of income with certain restraints.

Dairying As An Alternative

The dairy enterprise has a different problem because input items are lumpy. Production specialists specified that a minimum of 50 milking cows are required to produce fluid milk efficiently. The programming problem is different from that used above. The minimum number of cows becomes the limiting restraint and the problem is to maximize returns subject to the restraint. It is assumed that production is 9,000 pounds of fluid milk per cow. It is further assumed that all seasonal and full-time labor can be hired at the going wage rates and that land is available, but at a cost. Because of the labor demands of the dairy enterprise, cotton was not allowed to enter the program as an alternative income source. Again two situations are presented. Under situation I the operator can purchase corn and hay or produce them on the farm. Under situation II all corn and hay must be produced on the farm. But under both situations it was more economical to produce hay.

The minimum 50 cow milking herd dairy, under either situation, required more land than the average large size farm in the area (Table 13). Also, the investment required under either situation far exceeds that for farms of comparable size under the other organizations, although incomes and returns to land, labor, and management are comparable. This is also indicated by the relatively low returns on investment: 3.8 percent for situation I and 5.1 percent for situation II. Also, returns per acre of open land for situation I (\$18.00) was exceeded by 10 of the 11 previously presented organizations and for situation II (\$22.01) by 8 of the 11 organizations. Returns to the operator's labor per hour available, on the other hand, under situation II (\$2.45) was about equal to the average of the \$8,000 organization but the situation I returns (\$1.85) fell below all of the other organizations except for the Beef Cattle organization.

Net money farm income from either situation exceeded the \$8,000 income level specified earlier. But returns per acre of open land, per hour labor available and per dollar invested for dairy situation I exceeded only the Beef Cattle organization at the \$8,000 income level whereas returns for dairy situation II exceeded all but three of the other organizations at this income level. Thus under the condi-

tions specified for the dairy enterprise, it is more profitable to raise as much of the feedstuffs as possible on the farm. However, dairying in the area must be conducted on a large scale, possibly much larger than was programmed to be as profitable as other enterprises. The recent increases in the price of fluid milk, however, improved the competitive position of dairying as an alternative enterprise for the area. Returns could also be increased by either an increase in the production per cow provided cost increases are not offsetting, or a reduction in the cost of producing milk, or a combination of these.¹⁰

Hurt and McLaughlin concluded from their study of commercial dairy farms in Northeast Mississippi that farmers who have the capital to invest can earn a six percent return on their investment plus a return of around \$4,000 for their labor and management. However, returns to labor and management would not be sufficient to provide for substantial repayment of borrowed capital and for family living expenses. The same conclusions can be drawn from the data presented above.

¹⁰Hurt, Verner G. and McLaughlin, A. L., "Returns from Alternative Organizations, Grade 'A' Dairy Farms, Northeast Mississippi," Miss. Agr. Exp. Sta., Bul. 730, August 1966.

IMPLICATIONS

In 1964, there were 26,058 farms in the Clay-Hills of Mississippi, only about one-half the number that existed fifteen years earlier. The number of farms in the area continues to decline and based on historical data sources it is estimated that by 1975 there will be fewer than 20,000 farms in the 18 counties. This estimate is consistent with the estimated number for the State, over a period of years the area has had approximately one-fourth

of the total number of farms in the State. The area, over the years, has also contained about one-fourth of the low-income farmers in the State. These ratios are not expected to change much in the near future.

Farm income per family in 1964 was lower than nonfarm family income in the State and the Nation. For example, 70.7 percent of the commercial farms in the area had gross farm sales of less than

\$5,000 which, even after allowing for price increases, would yield less than \$3,000 net money farm income. Approximately two in five commercial farms in the area had gross farm sales of \$2,500 or less. In 1964, nearly a third of the farm households reporting had less than \$1,000 annual income from all sources and almost half (49.5 percent) had less than \$2,000 (86.3 percent of the families reported their incomes).¹¹ In all, five of every eight families reported incomes of less than \$3,000.

There are two problems in raising the level of farm income. They are size of farms and age of operator.

The size of the operating unit of about one-half of the operators in the area must be increased because about 45 percent of the farms had less than 20 acres of cropland or less than 70 total acres. Another 15.9 percent of the farms had less than 100 total acres, making almost 61 percent of the operators located on small farms. Less than 10 percent of the area farms could be classified as large (260 acres or more in size).

Increasing farm size either through purchase or rental may be retarded by both institutional and physical obstacles. Under the Mississippi Homestead Exemption Tax laws the tax cost of owning less than 160 acres of farm land in the Hills is small. Technically, the Homestead Exemption cannot be claimed for any part of the homestead that is rented in or out. Therefore, the incentive to rent-out land is reduced as well as the incentive to sell. Also, it is primarily the stream bottoms throughout the area that are rowcropped. Therefore, to increase the cropland acres in a farm usually would mean the renting of sizeable acreage to gain a few additional acres of cropland. Since it is the stream bottoms that are

cropped, the renting of additional land would probably increase drastically the time and cost involved in going from field to field. These costs are not recognized in the budgets.

The average age of farm operators in the Hills was almost 53 years in 1964 and will continue to increase slowly over time. The percentage of farm operators 65 years of age and older continues to increase and in 1964 almost a fourth (22.7 percent) of the operators fell into this age category. Also, approximately 15 percent of the operators had less than five years of formal schooling and five of eight had completed eight grades or less. Prior research in the area found that most farmers of that age or older either were not interested in, or, because of educational or physical deficiencies, were incapable of making adjustments in their farming operations, either in size or enterprises. Therefore, the number of farm operators in the area who can make the necessary changes appears to be small.

Personal preference and other non-economic factors influence the choice of enterprises on particular farms as well as economic factors. Institutional factors and patterns of ownerships inhibit the recombining of farms into economically sized units. Consequently, those farm operators who possess the necessary attributes for making major farm adjustments should be encouraged to do so. This encouragement could take the form of (1) information on the production alternatives, expected costs and returns, and investment needs, (2) credit information, and (3) adjustments in the institutional arrangements surrounding the control and use of land. For those farm people who are unable to make needed farm adjustments, a program of retraining for non-farm job opportunities, where possible, should be activated. Where this alternatives, expected costs and returns, program of welfare would be needed to increase the incomes of these people.

¹¹U. S. Department of Commerce, Bureau of the Census. "1964 United States Census of Agriculture Preliminary Report," Series AC 64-P1, Table 2, p. 2, August 1966.

FARM EMPLOYMENT OPPORTUNITIES UNDER SPECIFIED ORGANIZATIONS AND INCOME LEVELS

One of the major obstacles in estimating the effects of proposed changes in resource use is determining the probable mix of uses that will result. In the analysis of enterprise combinations presented above eleven different organizations for four levels of net money farm income were considered. These combinations and levels are by no means exhaustive for other production potentials and income levels could have been included; but even the ones considered, let alone the ones not considered, create a problem in estimating the possible mixture of combinations that could result.

An example of the shortcomings noted above is that if all farms throughout the area were converted to Feeder Pig operations (either with or without additional cash crops) and land were redistributed such that each farm had only the land resources necessary for \$3,000. The area could support more farms at a higher income level than now exists. In fact, if only Crops and Feeder Pigs I and II are considered as possibilities the approximate number of farms existing in 1964 could be raised to the \$5,000 income level. However, either of these situations is completely unrealistic because from 20 to 55 million feeder pigs would need to be sold, and a market exists for only a fraction of this number. A similar situation would exist if all farms were converted to market hog, beef or dairy operations.

Therefore, the number of farm adjustment opportunities available to the area would suggest a range between 9,100 and 52,600 farms depending on the farm organization and situation selected (Table 14). In all probability, the number would closely approximate the number of crop

farms because of the flexibility in diversification available to this group of farms. Naturally, as the area income target is raised the number of farming opportunities is decreased. The make-up of farms in the area probably would be a combination of various organizations even if all farms had the necessary resources to earn a specified income level.

At the higher income levels, the number of farming opportunities would be drastically reduced, but offsetting this to some extent would be an increase in the demand for both seasonal and full-time hired labor. Each of the \$8,000 organizations for crops and crops and livestock, if totally adopted throughout the area would require approximately 3,250,000 man days of hired labor. This would represent a reduction of approximately 6,000 man-year job opportunities from present estimated farm employment. For the \$8,000 livestock organizations the decrease in job opportunities from the present level of farm employment would be even more drastic, ranging from 16,000 to 23,000 depending on the type of livestock enterprise.

The demand for seasonally-hired labor for the crops and the crops and livestock organizations will be reduced as mechanization of the cotton harvest spreads to the Hill farms. Already, the number of cotton pickers operating in the Hills is substantial and the trend is towards increased use. Custom harvesting of cotton is becoming more and more commonplace. The largest demand for seasonally-hired workers in the Hills has centered around the hand harvesting of the cotton crop. Consequently, increased usage of the mechanical harvesters will greatly reduce the need for hired labor.

ADDITIONAL CAPITAL NEEDS FOR ATTAINING INCOME TARGETS

A large amount of additional capital would be needed to raise the typical small Sand-Clay Hill farm operator's income to the \$3,000 level. In 1964 there were 11,609 farms in the area that contained less than 70 acres of land and 14,364 farms who reported receiving less than \$3,000 farm family income. These data indicate the magnitude of the total additional capital needs if the incomes of farm operators in the area were to be raised to the \$3,000 level.

The farms on which the estimates are based were surveyed during 1961-62 and the data presented in Tables 15, 15a, 16 and 16a were adjusted to 1965-66 cost-price relationships. Assuming the programmed investment on the small farm is representative of the average investment on all small farms, then the total additional capital needed to raise all small farms to \$3,000 incomes would range between 196 and 322 million dollars, depending on the farm organization selected. Capital investment in machinery, equipment, livestock and, to a lesser extent, land would account for between 149 and 183 million dollars of the estimated needs. Capital investment per farm would need to be increased by a minimum of \$12,650 and funds to cover operating expenses by \$4,224, yielding a minimum capital need per farm of \$16,875.

To raise the incomes of medium sized farms to the \$3,000 level would require

considerably less additional capital, particularly investment capital, than needed for the small farms. For example, a medium size crop farm would need \$5,492 in additional capital to achieve the \$3,000 income level but only \$2,969 would go into capital investments in machinery, equipment, and land. The more intensive hog operations usually require a larger investment in equipment, but a smaller land investment, than the crop farms. But universally, the livestock operations require greater operating capital.

Based on crop farm needs, it would require additional capital estimated at 15 million dollars to raise those medium farms earning less than \$3,000 to that level. The livestock farms would require even more. In total it is estimated that between 200 and 350 million dollars in additional capital would be needed to raise the area's low-income farms to the \$3,000 level of income.

For example, if it is assumed that all farms in the area will be devoted to crops alone approximately \$235 million dollars in additional capital would be needed for all farms to achieve the \$3,000 income level. The bulk of these funds would be used for machinery and equipment, and land. If the number of farms in the area continues to decrease, as is expected, the capital needs to raise incomes in the area will be decreased. Nevertheless, considerable capital funds will still be needed to raise the incomes of those farm families remaining.

Table 1. Crop farms — Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income ¹			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ²	Ac.	133.9	178.5	284.7	454.2
Cropland	Ac.	39.4	52.5	65.7	105.0
Pastureland	Ac.	35.2	46.9	58.6	93.8
Woodland	Ac.	57.3	77.1	158.4	253.4
Enterprise: Cotton	Ac.	11.0	14.7	18.4	29.4
Corn	Ac.	28.4	37.8	47.3	75.6
Native pasture, idle	Ac.	35.2	46.9	58.6	93.8
Investment, total	Dol.	19,457	23,697	35,014	51,860
Land	Dol.	12,730	16,970	26,900	42,916
Mach., equip. and fac.	Dol.	6,727	6,727	8,114	8,946
Labor, total required	Hr.	2,233	2,977	3,361	5,377
Operator's	Hr.	482	642	443	709
Hired, total ³	Hr.	1,751	2,335	2,918	4,668
April	Hr.	22	29	47	76
May	Hr.	189	252	315	504
June	Hr.	167	223	278	445
July	Hr.	11	15	8	12
September	Hr.	409	545	681	1,089
October	Hr.	681	908	1,135	1,816
November	Hr.	272	363	454	726
Operating capital ⁴	Dol.	3,134	4,178	5,223	8,357
Returns:					
to land, labor & management ⁵	Dol.	2,693	3,591	4,520	7,233
to labor & management ⁶	Dol.	1,982	2,644	3,019	4,838
per acre open land	Dol.	3.93	11.98	17.06	24.31
per hour labor available	Dol.	0.95	1.26	1.45	2.33
per dollar investment	Pct.	1.26	4.76	5.76	9.39

¹Cash receipts minus specified cash expenses — depreciation and interest on investment not considered.

²Includes 2 acres for house lot and waste.

³All chop, pick and extra harvest labor hired.

⁴Funds necessary to cover current cash expenses.

⁵Net money farm income less depreciation.

⁶Net money farm income less depreciation and interest on investment.

Table 1a. Crop farms — Resource use and incomes of programmed farms when maximum use is made of the operator's labor.¹

Item	Unit	Level of net money farm income			
		\$3,490	\$4,329	\$5,321	\$8,254
Labor:					
Operator's	Hr.	1,240	1,353	1,220	1,336
Hired, total	Hr.	993	1,624	2,141	4,041
April	Hr.	-----	-----	-----	54
May	Hr.	86	183	199	432
June	Hr.	28	103	128	319
September	Hr.	241	374	518	948
October	Hr.	527	765	1,004	1,720
November	Hr.	111	199	292	568
Operating capital ²	Dol.	2,973	3,848	4,904	8,103
Returns: ²					
to land, labor and mgt.	Dol.	3,183	3,920	4,641	7,487
to labor and management	Dol.	2,472	2,973	3,340	5,092
per acre of open land	Dol.	10.50	15.29	19.64	25.59
per hour of labor available	Dol.	1.19	1.43	1.61	2.45
per dollar investment	Pct.	3.78	6.14	6.68	9.50

¹All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.

²See footnotes, Table 1.

Table 2. Crops and Feeder Pigs I farms¹ — Resources and enterprise combinations necessary for specified levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ²	Ac.	69.3	93.7	118.0	273.2
Cropland	Ac.	20.0	27.3	34.6	63.0
Pastureland	Ac.	18.0	24.5	30.9	56.2
Woodland	Ac.	29.3	34.9	50.5	152.0
Enterprise: Cotton	Ac.	5.6	7.5	9.7	17.7
Corn	Ac.	.9	.7	.5	21.4
Millet	Ac.				.9
Lespedeza	Ac.				5.1
Soybean	Ac.				2.5
Coastal Bermuda	Ac.	13.5	19.1	24.9	15.4
Native pasture, improved	Ac.	18.0	24.5	30.9	56.2
Livestock, hogs — sows	Hd.	60	84	108	108
Investment, total	Dol.	18,803	24,079	28,682	49,080
Land	Dol.	6,588	8,908	11,218	25,814
Mach., equip. and fac.	Dol.	8,840	10,446	11,389	17,191
Livestock	Dol.	3,375	4,725	6,075	6,075
Labor, total required	Hr.	1,794	2,448	3,139	4,597
Operator's	Hr.	983	1,364	1,741	1,929
Hired, total ³	Hr.	811	1,084	1,398	2,668
April	Hr.	1	1	—	21
May	Hr.	69	91	116	255
June	Hr.	58	76	97	219
July	Hr.	3	3	4	7
September	Hr.	204	274	354	650
October	Hr.	340	457	591	1,083
November	Hr.	136	182	236	433
Operating capital ²	Dol.	9,411	13,185	17,038	17,315
Returns: ²					
to land, labor and mgt.	Dol.	2,430	3,313	4,221	6,996
to labor and mgt.	Dol.	2,062	2,815	3,595	5,555
per acre open land	Dol.	0.79	17.62	27.80	38.56
per hour labor available	Dol.	0.99	1.35	1.73	2.67
per dollar investment	Pct.	0.28	3.50	5.68	8.86

¹Corn purchase or its equivalent permitted.²See footnotes, Table 1.³Crop labor could be hired at the going wage rates as needed. Livestock labor could be hired only for a full year at a salary of \$2,400.Table 2a. Crops and Feeder Pigs I Farms¹ — Resource use and incomes of programmed farms when maximum use is made of the operator's labor.²

Item	Unit	Level of net money farm income			
		\$3,235	\$4,204	\$5,137	\$8,110
Labor:					
Operator's	Hr.	1,534	1,864	2,112	2,231
Hired, total ³	Hr.	260	584	1,027	2,366
May	Hr.	—	12	76	240
June	Hr.	—	—	26	160
September	Hr.	60	159	267	589
October	Hr.	200	348	511	1,030
November	Hr.	—	65	147	347
Operating capital ³	Dol.	9,206	12,981	16,901	17,215
Returns: ³					
to land, labor and mgt.	Dol.	2,665	3,517	4,358	7,106
to labor and management	Dol.	2,297	3,019	3,732	5,665
per acre open land	Dol.	6.97	21.56	29.89	39.48
per hour labor available	Dol.	1.10	1.45	1.79	2.72
per dollar investment	Pct.	1.53	4.35	6.16	9.08

¹Corn purchase or its equivalent permitted.²All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.³See footnotes, Table 1 and footnote 3, Table 2.

Table 3. Crops and Feeder Pigs II Farms¹—Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ²	Ac.	83.6	110.1	137.4	286.0
Cropland	Ac.	24.3	32.3	40.4	65.9
Pastureland	Ac.	21.8	28.8	36.1	58.9
Woodland	Ac.	35.5	47.0	58.9	159.2
Enterprise: Cotton	Ac.	3.2	9.0	11.3	18.4
Corn	Ac.	16.8	18.5	24.4	40.7
Coastal Bermuda	Ac.	4.3	4.8	4.7	6.8
Native pasture—improved	Ac.	21.8	11.0	26.7	58.9
unimproved	Ac.	-----	17.8	9.4	-----
Livestock, hogs - sows	Hd.	36	36	48	84
Investment, total	Dol.	18,534	21,068	24,809	44,755
Land	Dol.	7,948	10,467	13,062	27,023
Mach., equip. and fac.	Dol.	8,561	8,576	9,047	13,007
Livestock	Dol.	2,025	2,025	2,700	4,725
Labor, total required	Hr.	1,344	2,380	3,064	4,354
Operator's	Hr.	866	971	1,290	1,650
Hired, total ²	Hr.	478	1,409	1,774	2,704
April	Hr.	13	14	18	41
May	Hr.	73	145	185	303
June	Hr.	66	127	162	266
July	Hr.	5	8	11	7
September	Hr.	96	334	419	626
October	Hr.	161	558	699	1,043
November	Hr.	64	223	280	418
Operating capital ²	Dol.	4,392	5,645	7,475	12,599
Returns: ²					
to land, labor and mgt.	Dol.	2,376	3,319	4,213	6,961
to labor and management	Dol.	1,932	2,734	3,484	5,453
per acre open land	Dol.	-0.52	15.04	23.70	36.55
per hour labor available	Dol.	0.93	1.31	1.68	2.62
per dollar investment	Pct.	0.74	5.08	7.65	9.88

¹Corn purchase or its equivalent not permitted. All feedstuff required to be produced on the farm.

²See footnotes, Table 1 and footnote 3, Table 2.

Table 3a. Crops and Feeder Pigs II Farms¹ — Resource use and incomes of programmed farms when maximum use is made of the operator's labor.²

Item	Unit	Level of net money farm income			
		\$3,177	\$4,262	\$5,218	\$8,147
Labor:					
Operator's	Hr.	1,303	1,603	1,793	2,062
Hired, total ³	Hr.	41	777	1,271	2,292
April	Hr.	-----	-----	-----	9
May	Hr.	-----	39	118	276
June	Hr.	-----	-----	50	187
September	Hr.	-----	221	341	538
October	Hr.	41	449	627	979
November	Hr.	-----	68	135	303
Operating capital ³	Dol.	4,215	5,383	7,257	12,452
Returns: ³					
to land, labor & management	Dol.	3,553	3,581	4,431	7,180
to land and management	Dol.	2,109	2,996	3,702	5,600
per acre open land	Dol.	3.32	19.33	26.55	37.72
per hour labor available	Dol.	1.01	1.44	1.78	2.69
per dollar investment	Pct.	1.69	6.32	8.53	10.21

¹Corn purchase or its equivalent not permitted. All feedstuff required to be produced on the farm.

²All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.

³See footnotes, Table 1 and footnote 3, Table 2.

Table 4. Crops and Market Hogs I Farms¹ — Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ²	Ac.	98.8	135.0	170.4	359.8
Cropland	Ac.	28.9	39.7	50.3	83.1
Pastureland	Ac.	25.8	35.5	44.9	74.2
Woodland	Ac.	42.1	57.8	73.2	200.5
Enterprise: Cotton	Ac.	8.1	11.1	14.1	23.3
Corn	Ac.	20.8	28.6	36.2	59.8
Native pasture—improved	Ac.	2.0	3.3	-----	-----
unimproved	Ac.	23.8	35.5	44.9	74.2
Livestock, hogs—pigs	Hd.	975	1,344	1,536	2,304
Investment, total	Dol.	24,157	32,181	37,415	62,327
Land	Dol.	9,393	12,834	16,200	33,996
Mach., equip. and fac.	Dol.	9,244	11,619	12,383	15,083
Livestock, pigs	Dol.	5,520	7,728	8,832	13,248
Labor, total required	Hr.	2,235	2,907	3,618	5,406
Operator's	Hr.	951	1,161	1,384	1,713
Hired, total ²	Hr.	1,284	1,746	2,234	3,693
April	Hr.	16	21	27	60
May	Hr.	139	191	241	399
June	Hr.	122	168	213	352
July	Hr.	8	12	15	9
September	Hr.	300	406	521	862
October	Hr.	499	677	869	1,436
November	Hr.	200	271	348	575
Operating capital ²	Dol.	28,320	39,605	45,334	68,109
Returns: ²					
to land, labor & management	Dol.	2,662	3,677	4,600	7,654
to labor and management	Dol.	2,137	2,961	3,696	5,777
per acre open land	Dol.	4.79	16.98	23.11	33.40
per hour labor available	Dol.	1.03	1.42	1.78	2.78
per dollar investment	Pct.	0.12	2.26	4.17	6.43

¹Corn purchase or its equivalent permitted.²See footnotes, Table 1 and footnote 3, Table 2.Table 4a. Crops and Market Hogs I Farms¹ — Resource use and incomes of programmed farms when maximum use is made of the operator's labor.²

Item	Unit	Level of net money farm income			
		\$3,303	\$4,292	\$5,260	\$8,126
Labor:					
Operator's	Hr.	1,578	1,808	1,944	2,087
Hired, total ³	Hr.	657	1,099	1,674	3,319
April	Hr.	-----	-----	-----	43
May	Hr.	26	120	202	369
June	Hr.	-----	54	123	276
September	Hr.	190	264	393	783
October	Hr.	395	550	759	1,389
November	Hr.	46	111	197	459
Operating capital ³	Dol.	28,007	39,303	45,074	67,983
Returns: ³					
to land, labor & management	Dol.	2,965	3,969	4,860	7,780
to labor and management	Dol.	2,440	3,253	3,956	5,903
per acre open land	Dol.	10.33	20.86	25.84	34.20
per hour labor available	Dol.	1.17	1.56	1.90	2.84
per dollar investment	Pct.	1.13	3.16	4.86	6.63

¹Corn purchase or its equivalent permitted.²All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.³See footnotes, Table 1 and footnote 3, Table 2.

Table 5. Crops and Market Hogs II Farms¹ — Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ²	Ac.	110.5	154.5	188.0	388.0
Cropland	Ac.	32.4	45.5	55.8	89.7
Pastureland	Ac.	28.9	40.7	49.9	80.0
Woodland	Ac.	47.2	66.3	81.3	216.3
Enterprise: Cotton	Ac.	9.1	12.7	15.6	25.1
Corn	Ac.	23.3	32.8	40.2	64.6
Native pasture—unimproved	Ac.	28.9	40.7	49.9	80.0
Livestock, hogs—pigs	Hd.	192	192	384	576
Investment, total	Dol.	19,704	25,038	31,617	51,888
Land	Dol.	10,502	14,682	17,961	36,659
Mach., equip. and fac.	Dol.	6,994	8,148	10,344	10,813
Livestock, pigs	Dol.	2,208	2,208	3,312	4,416
Labor, total required	Hr.	2,663	2,860	2,711	4,736
Operator's	Hr.	623	837	569	893
Hired, total ²	Hr.	1,440	2,023	2,142	3,843
April	Hr.	18	25	40	65
May	Hr.	155	219	268	430
June	Hr.	137	193	237	380
July	Hr.	10	13	6	10
September	Hr.	336	472	477	887
October	Hr.	560	787	796	1,479
November	Hr.	224	314	318	592
Operating capital ²	Dol.	6,153	7,198	11,167	17,684
Returns: ²					
to land, labor and mgt.	Dol.	2,447	3,341	4,269	7,073
to labor and management	Dol.	1,861	2,522	3,267	5,027
per acre open land	Dol.	0.77	10.92	17.68	27.54
per hour labor available	Dol.	0.89	1.21	1.57	2.42
per dollar investment	Pct.	1.15	4.41	6.27	8.85

¹Corn purchase or its equivalent not permitted. All feedstuff required to be produced on the farm.

²See footnotes, Table 1 and footnote 3, Table 2.

Table 5a. Crops and Market Hogs II Farms¹ — Resource use and incomes of programmed farms when maximum use is made of the operator's labor.¹

Item	Unit	Level of net money farm income			
		\$3,280	\$4,343	\$5,331	\$8,265
Labor:					
Operator's	Hr.	1,282	1,394	1,371	1,587
Hired, total ³	Hr.	781	1,466	1,340	3,149
April	Hr.	-----	-----	-----	22
May	Hr.	40	133	140	341
June	Hr.	-----	64	81	244
September	Hr.	216	385	309	742
October	Hr.	453	714	655	1,369
November	Hr.	72	169	155	431
Operating capital ³	Dol.	5,873	6,745	10,736	17,421
Returns: ³					
to land, labor & management	Dol.	2,727	3,684	4,600	7,338
to land and management	Dol.	2,141	2,865	3,598	5,292
per acre open land	Dol.	5.33	14.90	20.81	29.10
per hour labor available	Dol.	1.03	1.38	1.73	2.54
per dollar investment	Pct.	2.57	5.78	7.29	9.36

¹Corn purchase or its equivalent not permitted. All feedstuff required to be produced on the farm.

²All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.

³See footnotes, Table 1 and footnote 3, Table 2.

Table 6. Crops and Beef Cattle Farms — Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ¹	Ac.	128.0	169.0	271.8	437.6
Cropland	Ac.	37.6	50.1	62.6	101.1
Pastureland	Ac.	33.6	43.9	56.0	90.4
Woodland	Ac.	54.8	73.0	151.2	244.1
Enterprise: Cotton	Ac.	10.5	14.0	17.5	28.3
Corn	Ac.	22.8	31.0	38.0	62.5
Soybean hay	Ac.	3.5	5.1	5.8	10.1
Coastal Bermuda	Ac.	.8	-----	1.3	-----
Native pasture—unimproved	Ac.	33.6	43.9	56.0	90.4
Livestock—beef cows	Hd.	6	7	10	14
Investment, total	Dol.	19,519	23,318	39,053	62,356
Land	Dol.	12,169	16,067	25,681	41,347
Mach., equip. and fac.	Dol.	6,378	6,117	11,752	18,741
Livestock	Dol.	972	1,134	1,620	2,268
Labor, total required	Hr.	2,330	3,099	3,361	5,391
Operator's	Hr.	680	895	643	946
Hired, total ¹	Hr.	1,650	2,204	2,748	4,445
April	Hr.	17	23	38	63
May	Hr.	172	231	286	465
June	Hr.	151	203	251	408
July	Hr.	10	13	7	11
September	Hr.	390	520	650	1,049
October	Hr.	650	867	1,083	1,749
November	Hr.	260	347	433	700
Operating capital ¹	Dol.	3,070	4,071	5,117	8,326
Returns: ¹					
to land, labor and mgt.	Dol.	2,641	3,532	4,398	7,066
to labor and management	Dol.	1,962	2,635	2,965	4,758
per acre open land	Dol.	3.38	12.04	16.82	24.37
per hour labor available	Dol.	0.94	1.27	1.43	2.29
per dollar investment	Pct.	1.35	4.94	5.16	7.49

¹See footnotes, Table 1 and footnote 3, Table 2.Table 6a. Crops and Beef Cattle Farms — Resource use and incomes of programmed farms when maximum use is made of the operator's labor.¹

Item	Unit	Level of net money farm income			
		\$3,384	\$4,376	\$5,360	\$8,303
Labor:					
Operator's	Hr.	1,332	1,447	1,404	1,604
Hired, total ²	Hr.	998	1,652	1,959	3,787
April	Hr.	—	—	—	27
May	Hr.	70	160	164	384
June	Hr.	7	73	99	294
September	Hr.	269	428	481	901
October	Hr.	544	790	943	1,640
November	Hr.	108	201	270	541
Operating capital ²	Dol.	2,687	3,695	4,757	8,023
Returns: ²					
to land, labor and mgt.	Dol.	3,025	3,908	4,758	7,369
to labor and management	Dol.	2,346	3,011	3,325	5,061
per acre open land	Dol.	8.78	16.04	19.88	25.95
per hour labor available	Dol.	1.13	1.45	1.60	2.43
per dollar investment	Pct.	3.32	6.55	6.08	7.98

¹All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.²See footnotes, Table 1 and footnote 3, Table 2.

Table 7. Feeder Pigs I Farms¹ — Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ²	Ac.	76.3	103.4	174.0	355.1
Cropland	Ac.	22.2	30.3	39.9	82.0
Pastureland	Ac.	19.8	27.0	35.7	73.2
Woodland	Ac.	32.2	44.1	96.4	197.9
Enterprise: Corn	Ac.	1.3	-----	12.8	50.3
Lespedeza	Ac.	-----	-----	-----	4.2
Soybean hay	Ac.	-----	-----	-----	19.5
Coastal Bermuda	Ac.	20.9	30.3	27.1	8.0
Native pasture—improved	Ac.	19.8	27.0	35.7	60.1
unimproved	Ac.	-----	-----	-----	13.1
Livestock, hogs—sows	Hd.	84	120	120	96
Investment, total	Dol.	21,635	28,150	34,761	56,229
Land	Dol.	7,254	9,830	16,441	33,552
Mach., equip. and fac.	Dol.	10,156	11,570	11,570	17,277
Livestock	Dol.	4,225	6,750	6,750	5,400
Labor, total required	Hr.	1,292	1,805	2,083	2,131
Operator's	Hr.	1,285	1,805	2,019	1,873
Hired, total ²	Hr.	7	-----	64	258
April	Hr.	1	-----	10	56
May	Hr.	3	-----	25	101
June	Hr.	3	-----	26	101
July	Hr.	-----	-----	3	-----
Operating capital ²	Dol.	11,618	16,839	15,777	10,736
Returns: ²					
to land, labor and mgt.	Dol.	2,378	3,309	4,196	6,863
to labor and management	Dol.	1,973	2,760	3,278	4,990
per acre open land	Dol.	—0.52	15.86	23.76	28.76
per hour labor available	Dol.	0.95	1.33	1.58	2.40
per dollar investment	Pct.	0.38	2.34	4.42	7.54

¹Corn purchases or its equivalent permitted.²See footnotes, Table 1 and footnote 3, Table 2.Table 7a. Feeder Pigs I Farms¹ — Resource use and incomes of programmed farms when maximum use is made of the operator's labor.²

Item	Unit	Level of net money farm income			
		\$3,003	\$4,000	\$5,017	\$8,021
Labor:					
Operator's	Hr.	1,292	1,805	2,070	1,948
Hired, total ³	Hr.	0	0	13	183
April	Hr.	-----	-----	-----	56
May	Hr.	-----	-----	13	92
June	Hr.	-----	-----	-----	35
Operating capital ³	Dol.	11,618	16,839	15,760	10,715
Returns: ³					
to land, labor and mgt.	Dol.	2,381	3,309	4,213	6,884
to labor and management	Dol.	1,976	2,760	3,295	5,011
per acre open land	Dol.	—0.45	15.86	23.98	28.89
per hour labor available	Dol.	0.95	1.33	1.58	2.41
per dollar investment	Pct.	—0.38	2.34	4.42	7.58

¹Corn purchases or its equivalent permitted.²All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.³See footnotes, Table 1 and footnote 3, Table 2.

Table 8. Feeder Pigs II Farms¹ — Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ²	Ac.	94.2	125.4	193.1	355.1
Cropland	Ac.	27.5	36.8	44.4	82.0
Pastureland	Ac.	24.6	32.9	39.6	73.2
Woodland	Ac.	40.1	53.7	107.1	197.9
Enterprise: Corn	Ac.	24.4	28.7	34.7	50.3
Lespedeza	Ac.	-----	-----	-----	4.2
Soybean hay	Ac.	-----	-----	-----	19.5
Coastal bermuda	Ac.	3.1	8.1	9.7	8.0
Native pasture—improved	Ac.	24.6	32.9	39.6	60.1
unimproved	Ac.	-----	-----	-----	13.1
Livestock, hogs—sows	Hd.	36	60	72	96
Investment, total	Dol.	19,011	24,271	31,741	56,229
Land	Dol.	8,955	11,922	18,245	33,552
Mach., equip. and fac.	Dol.	8,031	8,974	9,445	17,277
Livestock	Dol.	2,025	3,375	4,051	5,400
Labor, total required	Hr.	1,073	1,528	1,644	2,131
Operator's	Hr.	951	1,384	1,471	1,873
Hired, total ²	Hr.	122	144	173	258
April	Hr.	18	22	26	56
May	Hr.	49	57	69	101
June	Hr.	49	58	69	101
July	Hr.	6	7	9	-----
Operating capital ²	Dol.	4,049	6,579	7,659	10,736
Returns: ²					
to land, labor and mgt.	Dol.	2,338	3,245	4,149	6,863
to labor and management	Dol.	1,838	2,579	3,131	4,990
per acre open land	Dol.	—1.19	12.12	20.82	28.76
per hour labor available	Dol.	0.88	1.24	1.51	2.40
per dollar investment	Pct.	0.50	3.62	5.35	7.37

¹Corn purchase or its equivalent not permitted. All feedstuff required to be produced on the farm.

²See footnotes, Table 1 and footnote 3, Table 2.

Table 8a. Feeder Pigs II Farms¹ — Resource use and incomes of programmed farms when maximum use is made of the operator's labor.²

Item	Unit	Level of net money farm income			
		\$3,050	\$4,073	\$5,072	\$8,021
Labor:					
Operator's	Hr.	1,073	1,528	1,613	1,948
Hired, total ³	Hr.	0	0	31	183
April	Hr.	-----	-----	-----	56
May	Hr.	-----	-----	31	92
June	Hr.	-----	-----	-----	35
Operating capital ³	Dol.	4,000	6,506	7,587	10,715
Returns: ³					
to land, labor and mgt.	Dol.	2,388	3,318	4,221	6,884
to labor and management	Dol.	1,888	2,752	3,203	5,011
per acre open land	Dol.	—0.23	13.17	21.68	28.89
per hour labor available	Dol.	0.91	1.32	1.54	2.41
per dollar investment	Pct.	0.76	3.92	5.58	7.58

¹Corn purchase not permitted.

²All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.

³See footnotes, Table 1 and footnote 3, Table 2.

Table 9. Market Hogs I Farms¹ — Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ²	Ac.	120.9	164.8	267.7	478.9
Cropland	Ac.	35.5	48.6	61.7	110.7
Pastureland	Ac.	31.7	43.4	55.1	98.9
Woodland	Ac.	51.7	70.8	148.9	267.3
Enterprise: Corn	Ac.	35.5	48.6	61.7	93.2
Soybean hay	Ac.	-----	-----	-----	17.5
Native pasture—improved	Ac.	1.7	1.0	.4	-----
unimproved	Ac.	30.0	42.4	54.7	98.9
Livestock, hogs—pigs	Hd.	1,152	1,536	1,920	1,536
Investment, total	Dol.	28,393	36,825	51,826	72,208
Land	Dol.	11,494	15,667	25,294	45,249
Mach., equip. and fac.	Dol.	10,275	11,222	14,388	17,023
Livestock—pigs	Dol.	6,624	9,936	12,144	9,936
Labor, total required	Hr.	1,156	1,561	1,639	1,898
Operator's	Hr.	978	1,318	1,330	1,414
Hired, total ²	Hr.	178	243	309	484
April	Hr.	27	37	62	93
May	Hr.	71	97	123	186
June	Hr.	71	97	124	187
July	Hr.	9	12	-----	9
August	Hr.	-----	-----	-----	9
Operating capital ²	Dol.	31,165	41,456	51,746	38,550
Returns: ²					
to land, labor and mgt.	Dol.	2,675	3,611	4,614	6,744
to labor and management	Dol.	2,034	2,737	3,203	4,219
per acre open land	Dol.	4.09	13.16	18.96	20.73
per hour labor available	Dol.	0.98	1.32	1.54	2.03
per dollar investment	Pct.	-0.52	1.61	2.53	5.63

¹Corn purchases or its equivalent permitted.²See footnotes, Table 1 and footnote 3, Table 2.Table 9a. Market Hogs I Farms¹—Resource use and incomes of programmed farms when maximum use is made of the operator's labor.²

Item	Unit	Level of net money farm income			
		\$3,071	\$4,096	\$5,082	\$8,052
Labor:					
Operator's	Hr.	1,156	1,503	1,553	1,558
Hired, total ³	Hr.	0	58	86	340
April	Hr.	-----	8	15	93
May	Hr.	-----	42	49	140
June	Hr.	-----	8	22	89
July	Hr.	-----	-----	-----	9
August	Hr.	-----	-----	-----	9
Operating capital ³	Dol.	31,091	41,360	51,664	38,498
Returns: ³					
to land, labor and mgt.	Dol.	2,746	3,707	4,696	6,796
to labor and management	Dol.	2,105	2,833	3,285	4,271
per acre open land	Dol.	5.15	14.21	19.66	20.97
per hour labor available	Dol.	1.01	1.36	1.58	2.05
per dollar investment	Pct.	-0.27	1.87	2.69	5.70

¹Corn purchase or its equivalent permitted.²All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.³See footnotes, Table 1 and footnote 3, Table 2.

Table 10. Market Hogs II Farms¹ — Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ²	Ac.	143.9	188.8	295.7	508.1
Cropland	Ac.	42.4	55.7	68.2	117.5
Pastureland	Ac.	37.8	49.8	60.9	105.0
Woodland	Ac.	61.7	81.3	164.6	283.6
Enterprise: Corn	Ac.	42.4	55.7	68.2	89.9
Soybean hay	Ac.	—	—	—	27.6
Native pasture—unimproved	Ac.	37.8	49.8	60.9	105.0
Livestock, hogs—pigs	Hd.	384	384	576	768
Investment, total	Dol.	24,172	29,595	42,503	65,065
Land	Dol.	13,680	17,949	27,940	48,008
Mach., equip. and fac.	Dol.	7,180	8,334	10,147	11,547
Livestock, pigs	Dol.	3,312	3,312	4,416	5,510
Labor, total required	Hr.	1,120	1,101	1,038	1,537
Operator's	Hr.	745	822	697	1,060
Hired, total ²	Hr.	375	279	341	477
April	Hr.	32	42	68	90
May	Hr.	85	112	137	180
June	Hr.	85	111	136	180
July	Hr.	11	14	—	—
September	Hr.	74	—	—	11
October	Hr.	74	—	—	16
November	Hr.	14	—	—	—
Operating capital ²	Dol.	8,643	8,777	12,715	17,410
Returns: ²					
to land, labor and mgt.	Dol.	2,372	3,250	4,208	6,884
to labor and management	Dol.	1,609	2,248	2,659	4,205
per acre open land	Dol.	—0.35	8.06	14.00	20.15
per hour labor available	Dol.	0.77	1.08	1.28	2.02
per dollar investment	Pct.	0.40	3.24	4.12	6.51

¹Corn purchase or its equivalent not permitted. All feedstuff required to be produced on the farm.²See footnotes, Table 1 and footnote 3, Table 2.Table 10a. Market Hogs II Farms¹—Resource use and incomes of programmed farms when maximum use is made of the operator's labor.²

Item	Unit	Level of net money farm income			
		\$3,099	\$4,115	\$5,125	\$8,081
Labor:					
Operator's	Hr.	957	1,035	1,006	1,211
Hired, total ³	Hr.	163	66	32	326
April	Hr.	—	30	14	90
May	Hr.	—	36	18	103
June	Hr.	—	—	—	106
September	Hr.	74	—	—	11
October	Hr.	75	—	—	16
November	Hr.	14	—	—	—
Operating capital ³	Dol.	8,554	8,662	12,590	17,329
Returns: ³					
to land, labor and mgt.	Dol.	2,471	3,365	4,333	6,965
to labor and management	Dol.	1,708	2,363	2,774	4,286
per acre open land	Dol.	0.86	9.15	14.97	20.52
per hour labor available	Dol.	0.82	1.14	1.33	2.06
per dollar investment	Pct.	0.81	3.63	4.42	6.63

¹Corn purchase or its equivalent not permitted. All feedstuff required to be produced on the farm.²All resources other than those indicated and all enterprise combinations are the same as for the programmed farms.³See footnotes, Table 1 and footnote 3, Table 2.

Table 11. Beef Cattle — Resources and enterprise combinations necessary for programmed levels of net money farm income.

Item	Unit	Level of net money farm income			
		\$3,000	\$4,000	\$5,000	\$8,000
Land, total ¹	Ac.	410.3	856.1	1,318.2	3,054.1
Cropland	Ac.	94.8	198.6	305.6	708.6
Pastureland	Ac.	84.7	176.9	273.0	633.1
Woodland	Ac.	228.8	478.6	737.6	1,710.4
Enterprise:					
Coastal Bermuda	Ac.	84.0	18.3	155.7	21.0
Dallis grass	Ac.	—	58.5	—	255.0
Native pasture—unimproved	Ac.	84.7	176.9	273.0	633.1
Cropland used as N. past.	Ac.	10.8	121.8	149.9	432.6
Livestock, cows	Hd.	90	90	210	300
Investment, total	Dol.	67,042	109,164	182,183	363,481
Land	Dol.	38,768	80,890	124,552	288,570
Mach., equip. and fac.	Dol.	13,694	13,694	23,611	26,311
Livestock, cows	Dol.	14,580	14,580	34,020	48,600
Labor, total required	Hr.	2,187	2,046	5,037	6,468
Operator's ²	Hr.	2,015	1,916	1,845	1,304
Hired, full time ¹	Hr.	—	—	2,574	4,720
Other	Hr.	172	130	618	444
Operating capital ¹	Dol.	4,026	3,054	11,008	14,767
Returns: ¹					
to land, labor and mgt.	Dol.	1,745	2,905	2,509	4,925
to labor and management	Dol.	—368	—1,609	—4,441	—11,177
per acre of open land	Dol.	—3.64	1.34	0.19	1.88
per hour labor available	Dol.	—0.18	—0.77	—2.14	—5.37
per dollar investment	Pct.	—0.77	0.44	0.03	0.53

¹See footnotes, Table 1 and footnote 3, Table 2.²No difference between hiring all extra harvest labor and maximum utilization of operator's labor.**Table 12. Increase in net money farm income above programmed levels when maximum use of the operator's labor is made, by types of farm organizations.**

Type farm organization and situation ¹	Increase in net money farm income above programmed levels ²			
	\$3,000	\$4,000	\$5,000	\$8,000
	Dollars			
Crops	490	329	321	254
Crops and Feeder Pigs I	235	204	137	110
Crops and Feeder Pigs II	177	262	218	147
Crops and Market Hogs I	303	292	260	126
Crops and Market Hogs II	280	343	331	265
Crops and Beef Cattle	384	376	360	303
Feeder Pigs I	3	0	17	21
Feeder Pigs II	50	73	72	21
Market Hogs I	71	96	82	52
Market Hogs II	99	115	125	81
Beef Cattle	0	0	21	37

¹Under I corn purchase or its equivalent is permitted.

Under II corn purchase or its equivalent is not permitted.

²For programmed levels of net money farm income all chop, pick and extra harvest labor hired. Maximum utilization of the operator's labor is limited to 220 hours per month, not all of which is available for field work. The monthly distribution of the operator's labor was assumed to be:

Month	Total	Field	Other	Month	Total	Field	Other
Jan.	220	120	100	July	220	200	20
Feb.	220	120	100	Aug.	220	220	0
Mar.	220	160	60	Sept.	220	200	20
April	220	160	60	Oct.	220	190	30
May	220	190	30	Nov.	220	170	50
June	220	190	30	Dec.	220	100	120
					2640	2020	620

Based on data in Parvin, D. W., "Farm Management Laboratory Manual," Mississippi State University, (Processed) (undated).

Table 13. Dairy, 50 cow milking herd — Optimum enterprise organizations and associated incomes, under two situations.

Item	Unit	Dairy—50 cow herd	
		Situation I ¹	Situation II ²
Land, total ³	Ac.	478.8	568.3
Cropland	Ac.	110.7	131.5
Pastureland	Ac.	98.9	117.5
Woodland	Ac.	267.2	317.3
Enterprise: Corn	Ac.	-----	37.1
Coastal Bermuda	Ac.	87.6	94.4
Bahia	Ac.	20.6	-----
Dallis grass	Ac.	2.6	-----
Native pasture—unimproved	Ac.	98.9	117.5
Livestock, milking cows	Hd.	50	50
Bulls, heifers and calves	Hd.	30	30
Investment, total	Dol.	109,482	119,624
Land	Dol.	45,240	53,696
Machinery, equipment and facilities	Dol.	42,867	44,553
Livestock, cattle	Dol.	21,375	21,375
Labor, total required	Hr.	4,618	5,016
Operator's utilized ⁴	Hr.	1,776	1,954
Hired, full time ³	Hr.	2,640	2,640
chop	Hr.	-----	186
other	Hr.	202	236
Operating capital ³	Dol.	14,116	14,540
Returns ³ — net money	Dol.	9,161	11,124
to land, labor and management	Dol.	6,377	8,097
to labor and management	Dol.	3,853	5,101
per acre open land	Dol.	18.0	22.01
per hour labor available	Dol.	1.85	2.45
per dollar investment	Pct.	3.80	5.10

¹Corn or its equivalent and hay purchase permitted.²Corn or its equivalent and hay purchase not permitted.³See footnotes, Table 1 and footnote 3, Table 2.⁴No difference between allowing operator to hire all chop and extra harvest labor and maximum utilization of operator's labor.Table 14. Estimated number of farms that could produce specified levels of net money farm income by farm organization and situation.¹

Farm organization and situation ²	Levels of net money farm income			
	\$,000	\$4,000	\$5,000	\$8,000
	— — — — — Number of farms — — — — —			
Crops	26,699	20,037	13,128	8,229
Crops and Feeder Pigs I	52,598	38,533	30,403	13,681
Crops and Feeder Pigs II	43,291	32,568	26,039	13,068
Crops and Market Hogs I	36,400	26,498	20,914	10,388
Crops and Market Hogs II	32,468	23,120	18,852	9,633
Crops and Beef Cattle	27,978	20,997	13,751	8,541
Feeder Pigs I	47,386	34,718	21,480	10,525
Feeder Pigs II	38,253	28,586	19,356	10,525
Market Hogs I	29,633	21,645	13,962	7,804
Market Hogs II	24,810	18,886	12,640	7,356
Beef Cattle	9,109	4,366	2,835	1,224

¹Estimated number of farms for each organization based on programmed acreage requirements and either total land in farms or croplands in farms in 1959, whichever yielded the smaller estimate.²Situation I — corn purchase or its equivalent permitted.

Situation II — corn purchase or its equivalent not permitted.

Table 15. Typical small Sand-Clay Hill farm (43 acres total, 18 acres of cropland)—Investment, operating capital, and net cash farm income for different farm types and levels of technology.

Item	Farm type and level of technology					
	Crops only			Crops and		
	Survey	Present	Advanced	Feeder pigs Advanced	Market hogs Advanced	Hogs ¹ Advanced
	\$	\$	\$	\$	\$	\$
Investment, total	5,887	5,120	7,642	9,431	10,970	13,059
Land	3,993	3,993	3,993	3,993	3,993	3,993
Mach. and equip.	720	720	3,349 ²	4,763	4,769	6,183
Livestock	1,174	407	300	675	2,208	2,883
Operating capital	165	165	1,452	2,925	6,859	8,372
Net cash farm income	1,043	1,314	1,476	2,171	2,086	2,781
Increase over survey farm:						
Net cash farm income	-----	+271	+433	+1,128	+1,043	+1,738
Investment, total	-----	—767	1,755	3,544	5,083	8,172
Land	-----	-----	-----	-----	-----	-----
Mach. and equip.	-----	-----	2,629	4,043	4,049	5,463
Livestock	-----	—767	—874	—499	1,034	1,709
Operating capital	-----	-----	1,287	2,760	6,694	8,207
Capital needs	-----	—767	3,042	6,304	11,777	16,379

¹Both feeder pigs and market hogs are produced.²Reflects change over from horse and mule drawn equipment to small tractor and equipment.

Source: Based on Crecink, John C. and McLaughlin, Albert L., "Increasing Income of Farm Families Through Farm Adjustments, Clay-Hills of Mississippi," Miss. Agr. Expt. Sta. AEc. M. R. No. 44, March 1965, Crecink, John C., "Budgets for Major Farm Enterprises in the Clay-Hills of Mississippi," Miss. Agr. Expt. Sta. AEc. M. R. No. 45, March 1965.

Table 15a. Programmed small Sand-Clay Hill farm with advanced technology¹ — Investment, operating capital and net cash farm income for different farm types.

Item	Farm type and level of technology		
	Crops and		Feeder Pigs I ²
	Feeder Pigs I ²	Feeder Pige II ³	
	\$	\$	\$
Investment, total	18,803	18,534	21,635
Land	6,588	7,948	7,254
Machinery and equipment	8,840	8,561	10,156
Livestock	3,375	2,025	4,225
Operating capital	9,206	4,392	11,618
Net cash farm income	3,235	3,177	3,003
Increase over Survey Farm:			
Net cash farm income	2,192	2,134	1,960
Investment, total	12,916	12,647	15,748
Land	2,595	3,955	3,261
Machinery and equipment	8,020	7,841	9,436
Livestock	2,201	851	3,051
Operating capital	9,041	4,227	11,453
Capital needs	21,957	16,874	27,701
Acreage	Acres	Acres	Acres
Total	23	41	33
Cropland	2	6	4

¹Total acreage varies considerably from the typical small farm acreage but cropland acres vary only by a few acres.²I Corn purchase or its equivalent permitted.³Corn purchase or its equivalent not permitted.

Table 16. Typical medium Sand-Clay Hill farm (117 acres total, 39 acres of cropland)—Investment, operating capital and net cash farm income for different farm types and levels of technology.

Item	Farm type and level of technology									
	Crops only			Crops and						
	Survey	Present	Advanced	Beef Present	Beef Advanced	Beef & Dairy Present	Dairy Present	Feeder Pigs Advanced		
Investment, total	\$	\$	\$				\$	\$		
Land	16,488	13,975	14,427	14,776	15,383	16,503	16,973	16,517		
Machinery and equipment	11,123	11,123	11,123	11,123	11,123	11,123	11,123	11,123		
Livestock	2,852	2,852	3,304	2,852	3,450	2,852	2,852	4,719		
Operating capital	2,513	—	—	801	810	2,528	2,998	675		
Net cash farm income	450	450	2,340	442	2,678	369	401	3,334		
Increase over Survey Farm:	1,857	1,981	3,126	2,248	3,169	2,354	2,344	3,811		
Net cash farm income	—	124	1,269	391	1,312	497	487	1,954		
Investment, total	—	—2,513	—2,061	—1,712	—1,105	15	485	29		
Land	—	—	—	—	—	—	—	—		
Machinery and equip.	—	—	452	—	598	—	—	1,867		
Livestock	—	—2,513	—2,513	—1,712	—1,703	15	485	—1,838		
Operating capital	—	—	1,890	—8	2,228	—81	—49	2,884		
Capital needs	—	—2,513	—170	—1,720	1,123	—66	436	2,913		

Source: Based on Crecink, John C., and McLaughlin, Albert L., Increasing Incomes of Farm Families Through Farm Adjustments, Clay-Hills of Mississippi," Miss. Agr. Expt. Sta. AEc M. R. No. 44, March 1965; Crecink, John C., "Budgets for Major Farm Enterprises in the Clay-Hills of Mississippi," Miss. Agr. Expt. Sta. AEc M. R. No. 45, March 1965.

Table 16a. Programmed medium Sand Clay Hill farms with advanced level of technology — Investment, operating capital and net cash farm income for different farm types.

Item	Farm type									
	Crops and:									
	Only	Beef	Feeder Pig I ¹	Feeder Pig I ¹	Feeder Pig II ²	Feeder Pig II ²	Market Hogs I ¹	Market Hogs I ¹	Market Hogs II ²	
Investment, total	\$ 19,457	\$ 19,519	\$ 24,079	\$ 28,682	\$ 21,068	\$ 24,809	\$ 24,157	\$ 32,181	\$ 19,704	
Land	12,730	12,169	8,908	11,218	10,467	13,062	9,393	12,834	10,502	
Mach. & equip. ²	6,727	6,378	10,446	11,389	8,576	9,047	9,244	11,619	6,994	
Livestock	—	972	4,725	6,075	2,025	2,700	5,520	7,728	2,208	
Operating capital	2,973	2,687	12,981	16,901	5,383	7,257	28,007	39,303	5,873	
Net cash farm income	3,490	3,384	4,204	5,137	4,262	5,218	3,003	4,292	3,280	
Increase over survey farm:										
Net cash farm income	1,326	1,527	2,347	3,280	2,405	3,361	1,446	2,435	1,423	
Investment, total	2,969	3,031	7,591	12,194	4,580	8,321	7,669	15,693	3,216	
Land	1,607	1,046	—2,215	95	—656	1,939	—1,730	1,711	—621	
Mach. & equip.	3,875	3,526	7,594	8,537	5,724	6,195	6,392	8,767	4,142	
Livestock	—2,513	—1,541	2,212	3,562	—488	187	3,007	5,215	—305	
Operating capital	2,523	2,237	12,531	16,451	4,933	6,807	27,557	38,853	5,423	
Capital needs	5,492	5,268	20,122	28,645	9,513	15,128	35,226	54,546	8,639	
Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	Acres	
Total	14	11	—23	1	—7	20	—18	18	—13	
Cropland	1	—1	12	4	—6	2	—9	1	—6	

Table 16a (Continued). Programmed medium Sand-Clay Hill farms with advanced level of technology
—Investment, operating capital and net cash farm income for different farm types.

Item	Farm type				
	Feeder pigs			Market hogs	
	I ¹	II ²	II ²	I ¹	II ²
	\$	\$	\$	\$	\$
Investment, total	28,150	19,011	24,271	28,393	24,172
Land	9,830	8,955	11,922	11,494	13,680
Mach. & equip.	11,570	8,031	8,974	10,275	7,180
Livestock	6,750	2,025	3,375	6,624	3,312
Operating capital	16,839	4,000	6,506	31,091	8,554
Net cash farm income	4,000	3,050	4,073	3,071	3,099
Increase over Survey Farm:					
Net cash farm income	2,143	1,193	2,216	1,214	1,242
Investment, total	11,662	2,523	7,783	11,905	7,684
Land	—1,293	—2,168	799	371	2,557
Mach. & equip.	8,718	5,179	6,122	7,423	4,328
Livestock	4,237	—488	862	4,111	799
Operating capital	16,389	3,550	6,056	30,641	8,104
Capital needs	28,051	6,073	13,839	42,546	15,788
Acreage	Acres	Acres	Acres	Acres	Acres
Total	—13	—24	9	4	27
Cropland	—8	—11	—2	—3	4

¹I Corn purchase or its equivalent permitted.

²II Corn purchase or its equivalent not permitted.

Opportunities In Hog Production In Mississippi

By

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PREFACE

Past studies of the economics of hog production have indicated hogs to generally be one of the more profitable enterprises available to Mississippi farmers. However, hog production in the state has been declining.

This study was made to examine several economic aspects of hog production in order to determine whether changing farming conditions in Mississippi, including declining corn production, changes in corn transportation rates, trends toward part-time farming, etc., have altered the potentialities of hog production.

The approach used in the study was one of "up-dating" the data contained in past studies, and to bring together some of the more important findings of studies of farm organization which included hogs as major enterprises. Readers interested in more details than contained in this report are invited to read the more detailed publications.

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Opportunities in Hog Production in Mississippi

By R. L. CALLEJAS and T. D. PHILLIPS*

INTRODUCTION

Although hog production in Mississippi generally follows national production cycles, the number of hogs produced in the state has declined considerably from the high levels of the 1940's. Since the mid-1950's, population of the state has been increasing, causing Mississippi to be a pork deficit state, even though commercial slaughter of hogs has increased during this period.

Earlier studies have indicated hogs to be profitable enterprises. Since many of the factors associated with hog production have undergone change in recent years, farmers need information to indicate the effect of these changes upon the relative profitability of hogs. Since much of the investment in hog production facilities has few alternative uses, information on trends may indicate the likely future of hog production.

The purpose of this study was to examine some of the major economic factors affecting hog production in Mississippi. Considered specifically were (1) present and future market potential for Mississippi produced pork, (2) estimated returns from pork production, and (3) the potential of hog production as an alternative enterprise on Mississippi farms.

In order to indicate the present market

potential for Mississippi hogs, production, marketings, and slaughter were related to consumption requirements. Production and consumption trends were projected to 1975 to indicate future potential. These results are presented in the next section.

In another section, costs for producing feeder pigs with 50 and 100 sows for the period 1960-1965 are presented. The returns for finishing 800 and 1600 market hogs annually, and for a combined feeder pig-market hog enterprise for the same period are also presented. Prices received for hogs in Mississippi and prices paid for corn at Jackson were used in these calculations. To indicate changes in the competitive position of Mississippi producers, prices received for hogs in Iowa and Mississippi and corn prices in St. Louis and Jackson are compared for the 1960-65 period. Changes in hog-corn ratios for Mississippi and the Corn Belt are also presented.

In the last section, the contribution of hog enterprises to the net returns from typical farm operations are indicated. This contribution might be viewed as an indication of the relative profitability of hogs.

PORK CONSUMPTION—HOG SUPPLY BALANCES

Pork Consumption

Total consumption of pork is dependent upon population and per capita consumption. Until the mid-1950's, Mississippi's population was declining (Appen-

dix A, Table 1). However, the state's population increased from less than 2.1 million in 1954 to more than 2.3 million in 1964. Based upon data for 1953-65, population is projected to be 2.5 million by 1975.

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Pork has been an important item in the diet of the typical United States con-

sumer. However, there has been a slight downward trend in per capita consumption (Figure 1).

Apparently, other meat products have been substituted for pork in the United States. While per capita consumption of pork has tended to decline, per capita consumption of both beef and poultry have been increasing.

Table 1. Pork consumption and production in live hog equivalents in Mississippi, 1965 and projected for 1975.

Item	1965	Projected 1975 (1,000 head)
Consumption*	1,100	1,272
Production	561	485
Deficit	539	787

*Consumption was converted from a carcass basis to a live-hog equivalent basis using the 1965 Mississippi average commercial slaughter weight of 228 pounds and a 60 percent dressing percentage.

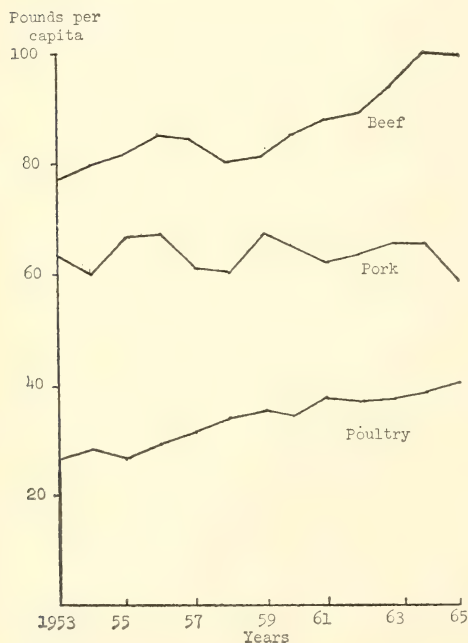


Figure 1. United States per capita consumption of beef, pork (excluding lard) and poultry, 1953-1965. Source: Appendix A, Table 2.

Pork consumption in the South has generally been estimated to exceed the national rate by 10 percent (5).¹ Based upon data for 1953-65, the 1975 per capita consumption for Mississippi was projected to be about 69.2 pounds per year as compared with 64.9 pounds in 1965 (Appendix A, Table 1).

Mississippi's estimated pork consumption was 151 million pounds for 1965. Consumption in 1975 is projected to be about 174 million pounds. Considering an average live weight of 228 pounds and a dressing percentage of 60, approximately 1.3 million hogs will be required to meet the 1975 requirements. (Table 1).

Hog Production

Hog production, as measured by the number raised, generally declined during the 1953-65 period (Appendix A, Table

¹Numbers in parentheses refer to the references cited.

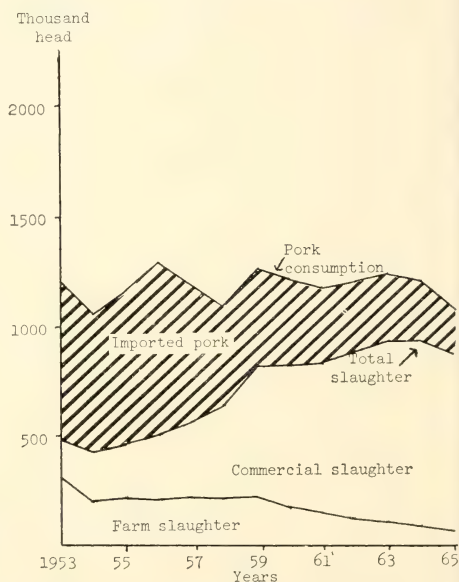


Figure 2. Mississippi pork requirements and farm and commercial slaughter, 1953-1965. Source: Appendix A, Table 4.

3). Projecting the 1953-65 trend, hogs produced in Mississippi will decline to about 485 thousand by 1975 compared with 561 thousand in 1965.

Consumption-Production Balances

Comparing consumption requirements with production, Mississippi hog producers provided about 50 percent of the state's 1965 requirements (Table 1). Projected production and consumption indicate the deficit will be about 787 thousand head in 1975.

Slaughter-Supply Balances

Although production of hogs has been declining in Mississippi, slaughter has been increasing to fill a higher proportion of pork consumption requirements (Figure 2). Farm slaughter decreased from 280 thousand head in 1953 to only 70 thousand head in 1965 (Appendix A, Table 4). Commercial slaughter during this same period increased from 207 thousand to 806 thousand head.

As indicated by Figure 2, rather large quantities of pork have been required from out-of-state sources. In 1965, the equivalent of 201 thousand live hogs was required as carcass pork from out-of-state sources to satisfy in-state requirements (Appendix A, Table 4).²

Even though pork production was less than consumption prior to 1958-59, many of the hogs apparently were shipped out of the state (Figure 3). Lack of in-state commercial slaughtering facilities resulted

in live hogs being shipped to other states for slaughter and then carcass pork being imported to satisfy consumption requirements.³

Marketing trends indicate that the number of hogs sold has gradually been increasing in spite of the decrease in population (Figure 3). This has been possible because of the decrease in farm slaughtering. However, since gains in marketings from this source will soon not be possible, marketings and production will be essentially the same except for allowances for breeding stock and intra-farm sales.

Even with the rapid increase in commercial slaughter since 1958-59, Mississippi has become a hog-deficit state to meet the requirements for commercial slaughter (Figure 3). In 1965, at least 335 thousand head were required from out-of-state sources, assuming that all marketings were available for commercial slaughter (Appendix A, Tables 4-5).⁴

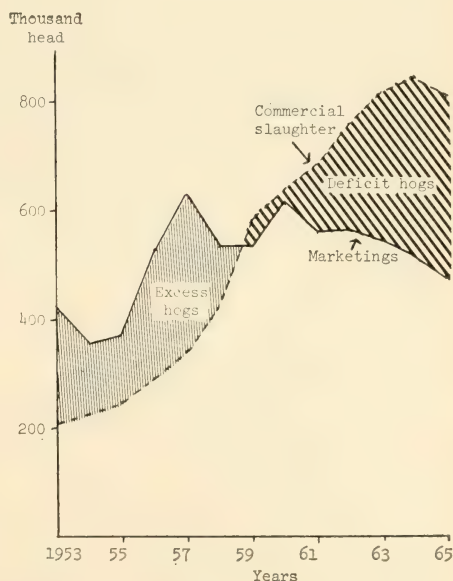


Figure 3. Relationship between marketing and commercial slaughter in Mississippi, 1953-1965. Source: Appendix A, Table 5.

²Total imports of live hogs were greater than 201 thousand head since Mississippi packing plants ship large quantities of pork to out-of-state markets.

³No doubt many of these hogs were slaughtered in-state by small local butchers whose slaughter estimates are not contained in either farm or commercial slaughter numbers.

⁴Probably this deficit is considerably understated because of duplicate counting of market hogs sold earlier as feeder pigs, breeding stock not available for slaughter, and hogs sold in markets across the state line.

Consumption-Slaughter-Production Balances

If trends in commercial slaughter continue, importation of carcass pork could drop to relatively low levels, depending upon the quantity of commercially slaughtered pork which remains in the state to meet domestic requirements. However, the gap between hogs commercially slaughtered and available supplies from Mississippi continues to widen. In 1965, the equivalent of 536 thousand head were imported (Appendix A, Table 5). As measured by demand and available supplies, these data indicate a tremendous potential for hog production in Mississippi. An analysis of production, marketings, slaughter, and consumption of livestock and meats in the South indi-

cates the states surrounding Mississippi to have similar production-consumption balances (4).

A continuation of the 1953-65 trend indicates more than a doubling of the 561 thousand head produced in Mississippi in 1965 will be needed to meet consumption estimates of 1,272 thousand by 1975 (Table 1). A price analysis based on 1958 conditions of production and consumption in the United States explored the effects of doubling Mississippi's production while leaving that of all other states unchanged (6). This analysis indicated that a doubling of the state's production would have resulted in a lowering of the price received by Mississippi farmers by only \$.47 per hundredweight on a live basis.

RETURNS TO HOG PRODUCERS

In the preceding section opportunities in hog production were examined by comparing Mississippi's pork consumption and production in relation to the state's requirements. In this section, opportunities are examined from the viewpoint of the profitability of hogs as major farm enterprises.

Since both deficit hog and corn supplies are obtained from the Corn Belt, trends in relative hog and corn prices for the Corn Belt and Mississippi are presented to show changes in Mississippi's competitive situation.

Costs of Production

Hog production may be confined to producing feeder pigs or to finishing feeder pigs to market weights. Many producers, however, prefer to do both jobs.

For this section the highlights of an earlier study⁵ were updated in order to indicate the cost of hog production in Mississippi based on the 1960-65 average price for corn at Jackson. Cost estimates were made for feeder pigs, hog finishing,

and a combination of the two enterprises. Estimates considering 8 pigs saved per litter and a 3.5 feed conversion ratio in the finishing operation are presented in this report. Estimates of costs are for 50-sow, 800 pig and 100-sow, 1600 pig enterprises.

Investment in land is not included in total investment because it was assumed that land would already be available; however, a charge of 5 percent on land valued at \$100 per acre is included in costs.

Feeder Pig Enterprises. A 50-sow feeder pig enterprise requires an approximate investment of \$8,500 including breeding stock but exclusive of the 7.5 acres of land required (Appendix B, Table 3). Sufficient economies of size exist to make the investment cost of a 100-sow opera-

⁵This study, by B. H. Jacks and T. D. Phillips, *Cost of Producing Hogs in Confinement*, Miss. Agri. Exp. Sta. Bul. 628, October 1961, considered the effects upon costs of (1) size of enterprise, (2) number of pigs saved per litter, and (3) feed conversion ratio. The revised feed ingredient prices are presented in Appendix B, Tables 1 and 2.

tion approximately \$15,500, exclusive of the required 14 acres.

Based on two litters of pigs averaging 40 pounds at weaning, costs including labor and interest on land were estimated to be \$8,143 annually, or \$10.80 per pig, for the 50-sow operation (Table 2). Costs per pig for the 100-sow operation were slightly lower—\$10.06. Annual labor requirements would be about 14.2 hours per sow for both enterprises. The smaller enterprise requires approximately two hours per day and the larger one about 4

Hog Finishing Enterprises. Less investment capital and less labor are required to finish pigs to market weight than is required to produce them as feeders. Exclusive of land, the investment in facilities required to feed out 800 hogs per year was estimated to be \$6,214 and to be \$10,728 for 1600 hogs (Appendix B, Table 5). About an acre of land

would be required for each size operation. The 800-hog operation requires 1.10 hours per day while the 1600-hog enterprise requires 1.67 hours.

Total cost of feeding hogs from 40 pounds to 200 pounds including a charge for labor and interest on land were \$14,521 and \$28,583 for the 800 and 1600-hog enterprises, respectively (Table 3). Estimated costs per pig were \$18.15 and \$17.88 for the small and large enterprises, respectively. Costs per hundredweight added in the finishing operation were \$11.34 for the smaller operation and \$11.18 for the 1600-head operation (Table 3).

Feeder Pig-Finishing Hog Enterprises

Total costs of producing the feeder pig and finishing the hog, including labor and interest in land, amounts to \$28.33 per head or \$14.17 per hundredweight for the 50-sow, 800-head operation (Table

Table 2. Costs of producing feeder pigs for selected size enterprises, 8 pigs saved per litter, 2 litters per year.

Item	Size of enterprise	
	50 sows	100 sows
	(dollars)	
Total costs:		
Feed	5,403	10,806
Interest on breeding stock	132	265
Labor	888	1,775
Interest on land ¹	38	70
All other costs	1,682	3,184
Total	8,143	16,100
Per pig costs:		
Feed	6.75	6.75
Interest on breeding stock	.17	.17
Labor	1.11	1.11
Interest on land	.05	.04
All other costs	2.10	1.99
Total	10.18	10.06

Source: Appendix B, Table 6. Land and labor requirements from Miss. Agri. Exp. Sta. Bul. 628 **Cost of Producing Hogs in Confinement**, October, 1961. Labor rate raised from \$1.00 to \$1.25 per hour.

¹Based on \$100 per acre at 5% interest.

Table 3. Costs of finishing selected number of hogs to 200-pound weights with a 3.5 feed conversion ratio.

Item	Number fed annually	
	800	1,600
	(dollars)	
Total costs:		
Feed	13,289	26,573
Labor	500	760
Interest on land ¹	5	5
All other costs	729	1,250
Total	14,523	28,588
Per pig costs:		
Feed	16.61	16.61
Labor	.62	.48
Interest on land	.01	.01
All other costs	.91	.78
Total	18.15	17.88
Per hundredweight of gain	11.34	11.18
Per hundredweight including feeder pig	14.17	13.97

Source: Appendix B, Table 6. Land and Labor requirements from Miss. Agri. Exp. Sta. Bul. 628, **Cost of Producing Hogs in Confinement**, October, 1961. Labor raised from \$1.00 to \$1.25 per hour.

¹Based on \$100 per acre at 5% interest.

3). Total costs excluding labor amount to \$26.60 per head or \$13.30 per hundredweight.

For the larger operation, total costs per head including labor and interest on investment in land are \$27.94 per head or \$13.97 per hundredweight. Excluding labor costs in both phases reduces costs to \$26.35 per head or \$13.17 per hundredweight.

Returns

In the previous section costs were presented on the basis of the 1960-65 average price for corn. Since corn makes up approximately 55 percent of the total cost of producing hogs exclusive of labor for the system considered in this study, returns were calculated for each year for

the period 1960-65 using the corn and hogs prices prevailing in the particular year.

Based on average corn and hog prices for the period, returns to labor and management would have been \$2.40 per hundredweight for the 800-head operation and \$2.53 for the 1600-head enterprise (Appendix B, Table 8). Considering corn and hog prices for individual years, returns for the 1600-head enterprise would have varied from a low of \$1.16 per hundredweight in 1964 to a high of \$5.77 per hundredweight in 1965 (Figure 5). Returns from the smaller operation would have averaged \$.13 per hundredweight less each year.

Mississippi's Competitive Position

Mississippi's competitive position in hog production depends upon the prices paid

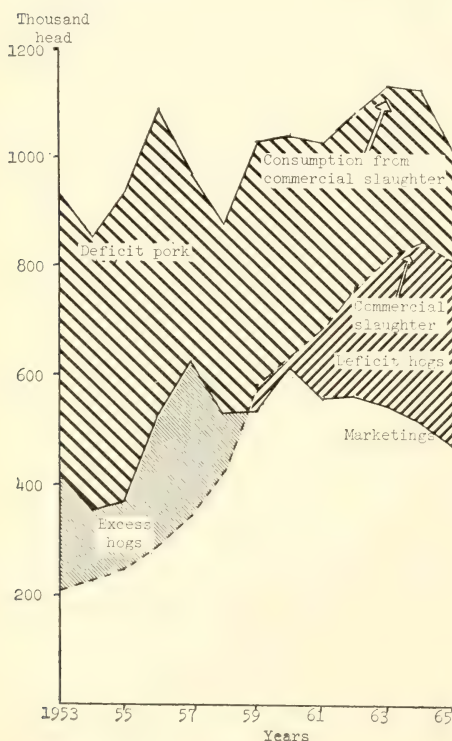


Figure 4. Consumption from commercial slaughter, commercial slaughter, and marketings in Mississippi, 1953-1965.

Source: Appendix A, Table 5.

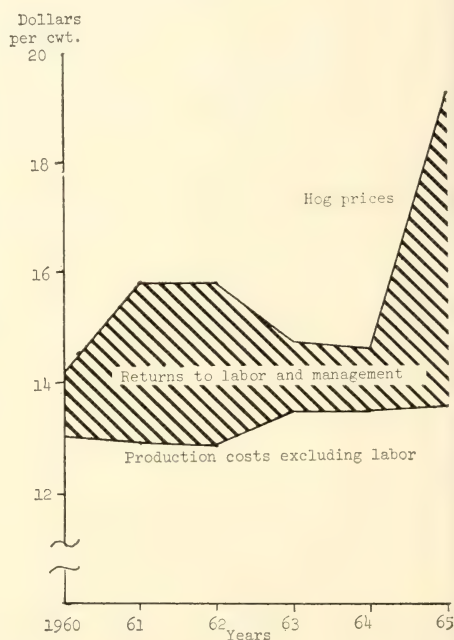


Figure 5. Hog prices, costs of production, and returns to labor and management for 1,600 head enterprise, Mississippi, 1960-65. Source: Appendix B, Tables 7 and 8.

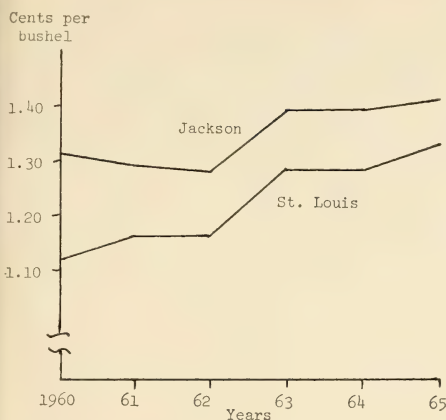


Figure 6. Prices of number 2 yellow corn at Jackson, Mississippi, and at St. Louis, 1960-65. Source: Appendix B, Table 2.

for inputs and the prices received for hogs. Since as indicated above corn makes up approximately 55 percent of the costs of producing hogs for the systems considered in this study, corn prices for Jackson and St. Louis for 1960-65 were compared (Figure 6). Hog price comparisons were made on basis of prices received by Mississippi and Iowa farmers (Figure 7).

Until 1965, Mississippi farmers were gaining relative to Iowa on prices received for hogs (Figure 7). In 1964, prices were equal in both states; however, in 1965, the Iowa price was \$1.53 above the Mississippi price (Appendix B, Table 7).

In 1960, the hog corn-ratio in Mississippi was only 10.84 compared with 13.66 in the Midwest. By 1964, the ratio was 10.50 in Mississippi and 11.41 in the Midwest. The relatively high Midwest



Figure 7. Hog prices received by Mississippi and Iowa farmers, 1960-65. Source: Appendix B, Table 7.

hog price in 1965 compared with the Mississippi price gave comparative ratios of 13.66 for Mississippi and 15.63 for the Midwest.⁶

If the 1965 relative price situation were unusual and the trend of the earlier 5 years is followed in the future, the Mississippi producer will find returns on a more comparable level with those of Corn Belt hog producers.

⁶Due primarily to reduced rail rates, corn price differentials between St. Louis and Mississippi have been reduced from 19 cents in 1960 to 8 cents in 1965.

HOGS AS AN ALTERNATIVE ENTERPRISE

In the previous sections it was shown that a potential market exists for hogs and that hogs would have yielded a relatively high rate of returns in Mississippi during the 1960-65 period. How-

ever, the real measure of hogs as an enterprise must be based on how they compare with competing enterprises and how well they fit into the combination of enterprises on the typical farm.

Table 4. Small Farm: Optimum enterprise organizations and associated incomes, under given resources and advanced technology, Clay-Hills of Mississippi.

Item	Unit	Crops	Enterprise combinations		
			Crops and feeder pigs	Crops and market hogs	Crops, F.P., and M.H.
Livestock:					
Hogs					
Sows	each	----	12	----	12
Pigs	each	----	----	192	192
Cows	each	----	----	----	----
Investment	dollar	7,642	9,431	10,970	13,059
Operating capital	dollar	1,452	2,925	6,859	8,372
Labor:					
Operator					
Available	hour	2,640	2,640	2,640	2,640
Utilized	hour	805	975	901	1,145
Hired	hour	699	699	699	699
Net cash income ¹	dollar	1,476	2,171	2,086	2,781
Returns to land, labor and management ²	dollar	1,331	1,870	1,726	2,376

Source: Adapted from Crecink, J. C. and McLaughlin, A. L., **Increasing Incomes of Farm Families Through Farm Adjustment, Clay-Hills of Mississippi** Miss. Agri. Exp. Sta. AEc M. R. No. 44, March, 1965.

¹Cash receipts minus cash expenses.

²Does not include value of farm prerequisites used or the rental value of the home.

Table 5. Medium Farm: Optimum enterprise organizations and associated incomes, under given resources and advanced technology, Clay-Hills of Mississippi.

Item	Unit	Enterprise combinations					
		Crops only		Crops and feeder pigs		Crops and beef	
		with alfalfa	with corn	with alfalfa	with corn	with alfalfa	with corn
Livestock:							
Beef	head	----	----	----	----	7	5
Hogs—sows	head	----	----	12	12	----	----
Investment	dollar	14,427	14,427	16,517	16,517	15,765	15,383
Operating capital	dollar	2,276	2,340	3,546	3,334	2,393	2,678
Labor: Operator							
Available	hour	2,640	2,640	2,640	2,640	2,640	2,640
Utilized	hour	749	1,056	821	1,229	885	1,149
Hired	hour	868	1,460	848	1,460	848	1,450
Net cash income ¹	dollar	3,609	3,126	4,402	3,811	4,090	3,169
Returns to land, labor and management ²	dollar	3,488	2,820	4,092	3,432	3,653	2,867

¹Cash receipts minus cash expenses.

²Does not include value of farm prerequisites used or the rental value of the home.

Source: Adapted from Crecink, J. C. and McLaughlin, A. L., **Increasing Incomes of Farm Families Through Farm Adjustment, Clay-Hills of Mississippi**, Miss. Agri- Exp. Sta. AEc. M. R. No. 44, March, 1965.

Optimal farm organization studies⁷ indicate that the production of feeder pigs and hog finishing operations would sub-

stantially improve the incomes of many Mississippi farmers (1, 2, 7). The material upon which this section is based is one of the more recent of these studies.⁸

⁷These studies were conducted by the Department of Agricultural Economics of the Mississippi Agricultural Experiment Station and by the U. S. Department of Agriculture.

⁸The publication is entitled, **Increasing Incomes of Farm Families Through Farm Adjustments, Clay-Hills of Mississippi** (1).

The study was based upon a survey to ascertain an inventory of existing farm resources.⁹ Farms were classified by size according to acres of cropland.

For the farms surveyed, the average small farm, which consisted of 18 acres of cropland and 43 acres in total land, had returns to land, labor, and management of only \$1,016 per farm in 1961 (Appendix C, Table 1). Medium farms with 39 and 117 acres of cropland and total land, respectively, had returns of \$1,762. Large farms returned an average of \$3,461 from 75 acres of cropland and 325 total acres.

With the same land holdings and the adoption of recommended practices and techniques, optimal enterprise combinations were calculated. The method used to obtain these combinations first considered only the optimal combination of crops and then allowed for a crops-livestock combination.

With the adoption of recommended practices on the small farms, the optimal combination of crop enterprises would

yield returns of \$1,331 to land, labor, and management (Table 4). Crops and feeder pigs gave returns of \$1,870, while crops and market hogs would yield \$1,726. However, if both feeder pigs and market hogs were used in the optimum combination with crops, returns increased to \$2,376.

Returns for the medium size farms would yield \$3,488 for the optimum all crops combination which included alfalfa (Table 5). Allowing beef cattle to be considered but not hogs, increased returns to \$3,653. However, the optimum crops-livestock combination which included feeder pigs gave returns of \$4,092.

On large farms the best crop enterprises yielded returns of \$5,447 (Table 6.) Allowing hog enterprises to be considered in combination with crops, returns were increased to \$5,636 if the combination contained market hogs. However, if feeder pigs were in the combination, returns jumped to \$7,409. The best crop enterprises with beef ranked second at \$6,257.

Other studies indicate similar results for hill farms, especially with underem-

⁹See Appendix C, Table 1 for an inventory of resources for each size group.

Table 6. Large Farm: Optimum enterprise organizations and associated incomes, under given resources and advanced technology, Clay-Hills of Mississippi.

Item	Unit	Enterprise combinations					
		Crops only		Crops and hogs		Crops and beef	
		with alfalfa	with corn	Feeder pigs	Market hogs	with alfalfa	with corn
Livestock: Beef	head	----	----	----	----	18	10
Hogs							
Sows	head	----	----	96	----	----	----
Pigs	head	----	----	----	2,304	----	----
Investment	dollar	41,637	39,151	59,338	83,051	46,075	41,402
Operating capital	dollar	6,583	5,969	15,607	67,993	6,734	6,092
Labor: Operator							
Available	hour	2,640	2,640	2,640	2,640	2,640	2,640
Utilized	hour	1,081	1,077	2,526	2,329	1,415	1,273
Hired	hour	2,708	2,763	2,693	2,663	2,698	2,719
Net cash income ¹	dollar	6,098	5,950	9,168	7,552	6,929	6,216
Returns to land, labor and management ²	dollar	5,447	5,402	7,409	5,636	6,257	5,660

Source: Adapted from Crecink, J. C. and McLaughlin, A. L., **Increasing Incomes of Farm Families Through Farm Adjustments**, Clay-Hills of Mississippi, Miss. Agri. Exp. Sta. AEc. M. R. No. 44, March, 1965.

¹Cash receipts minus cash expenses.

²Does not include value of farm prerequisites used or the rental value of the home.

ployment of labor. Hog enterprises require only small acreages and relatively low investment. Hogs may also have a place on small and medium Delta farms with sufficient land capable of high corn yields for providing feed for the animals.

especially finishing enterprises.

Hogs enterprises are not only profitable in combination with other farm enterprises, but they fit in well with off-farm employment because of the limited labor requirements.

SUMMARY

Over the past several years the production of hogs in Mississippi has been declining, even though several studies have indicated hog production would have been profitable during this period. This study was made to analyze the major economic factors affecting hog production in the state.

Projections of trends of pork requirements for Mississippi and of production in the state indicate deficit supplies may reach about 800 thousand head in 1975 compared to an estimated 539 thousand head shortage in 1965. If these trends continue, by 1975 pork consumption within the state will be more than double in-state production. A study based on 1958 data indicated that doubling of Mississippi's production, leaving production in other states unchanged, would have lowered the price received by farmers by less than \$.50 per hundredweight.

Another study indicated that for the 1960-65 period, estimated returns to labor and management would have averaged \$2.53 per hundredweight for a hog enterprise in which 1600 hogs were fed a year. Estimated returns to labor and management would have varied from a low of \$1.16 per hundredweight in 1964 to a high of \$5.77 in 1965.

Examination of hogs and corn prices

for Mississippi and the Midwest, indicates the competitive position of the state's hog producers has generally been improved in the last few years. The hog-corn ratio in 1960 was 10.84 for Mississippi compared with 13.66 for the Midwest. The spread steadily declined until 1964 when the ratios were 10.50 and 11.41 for Mississippi and the Midwest, respectively. However, in spite of improvement of Mississippi's ratio to 13.66 in 1965, the Midwest's ratio was 15.63 because of relatively higher prices for hogs in the Midwest.

Hogs would fit well into the operation of many farms in most areas of Mississippi. A recent study shows that the addition of a feeder pig enterprise to a typical middle-size farm of 39 acres of cropland and 117 total acres in the Clay Hills could have increased returns to labor and management from \$3,609 to \$4,402.

With the trend toward off-farm employment, hogs could offer part-time farm employment opportunities, especially for farmers who do not own sufficient land for enterprises such as beef cattle. Under such conditions, finishing hogs would be particularly well adapted because of the relatively low investment and labor requirements.

APPENDIX A

Table 1. Population and per capita pork consumption, Mississippi, 1953-65 and 1975 projections.

Year	Population (1,000)	Per capita pork consumption ¹ (pounds per year)
1953	2,131	69.9
1954	2,079	66.0
1955	2,079	73.5
1956	2,120	74.0
1957	2,133	67.2
1958	2,121	66.2
1959	2,162	74.4
1960	2,178	71.7
1961	2,218	68.4
1962	2,261	70.4
1963	2,290	72.0
1964	2,298	71.8
1965	2,321	64.9
1975	2,512	69.2

Source:

Population. Census of Population, P-21 Series, October each year.

Pork consumption: Livestock and Meat Situation, AMS, USDA, July 1965; and Livestock and Meat Statistics, SRS-ERS, USDA, August 1966.

¹Per capita pork consumption in Mississippi was estimated to be 10 percent above the U. S. level.

Table 2. Per capita consumption of pork, beef, and poultry meats for the United States, 1953-1965.

Year	Pork (excl. lard) (lbs. per year)	Beef	Poultry
1953	63.5	77.6	26.7
1954	60.0	80.1	28.1
1955	66.8	82.0	26.3
1956	67.3	85.4	29.6
1957	61.1	84.6	31.4
1958	60.2	80.5	34.0
1959	67.6	81.4	35.2
1960	65.2	85.2	34.3
1961	62.2	88.0	37.6
1962	63.8	89.1	37.0
1963	65.7	94.6	37.5
1964	65.6	100.1	38.4
1965	59.0	99.6	40.5

Source: Livestock and Meat Situation, AMS, USDA, July 1963; Poultry and Egg Situation, ERS, USDA, November 1965; and Livestock and Poultry Statistics, SRS-ERS, USDA, August 1966.

Table 3. Hogs raised and marketed in Mississippi, 1953-1965, and 1975 projections.

Year	Raised (1,000 head)	Marketed
1953	653	427
1954	702	354
1955	877	371
1956	902	530
1957	860	630
1958	825	532
1959	973	537
1960	770	618
1961	696	560
1962	712	564
1963	667	544
1964	566	516
1965	561	471
1975	485	671

Source: Meat Animals—Farm Production, Disposition and Income by States, USDA Stat. Bul. Nos. 113, 184, and 284, annual issues, 1962-1965; and Mississippi Meat Animals—Farm Production, Disposition and Income, Miss. Crop and Livestock Reporting Service, USDA, Stat. Rept. Service, May 1966.

Appendix A, Table 4. Pork requirements and slaughter in Mississippi, 1953-65.

Year	Pork requirements ¹	Farm slaughter	Require from commercial slaughter ²	Commercial slaughter	Imported pork ³
			(1,000 hog equivalents)		
1953	1,216	280	936	207	729
1954	1,057	200	857	227	630
1955	1,161	215	946	247	699
1956	1,299	210	1,089	291	798
1957	1,193	225	968	343	625
1958	1,098	220	878	423	455
1959	1,254	225	1,029	584	445
1960	1,214	175	1,039	639	400
1961	1,175	150	1,025	685	340
1962	1,203	120	1,083	760	323
1963	1,241	110	1,131	816	315
1964	1,209	90	1,119	842	277
1965	1,077	70	1,007	806	201

¹Estimated by raising U. S. per capita consumption by 10 percent. Converted to live weight basis using the U. S. commercial slaughter dressing percentages each year and the average live weight of hogs commercially slaughtered in Mississippi.

²Col. 1 minus Col. 2.

³Col. 3 minus Col. 4

Appendix A, Table 5. Consumption, farm slaughter, marketings, and deficit hogs and pork in Mississippi, 1963-65.

Year	Consumption requirements	Farm slaughter	Consumption from commercial slaughter ¹	Marketings	Deficit hog and pork ²
			(1,000 hogs)		
1953	1,216	280	936	427	509
1954	1,057	200	857	354	503
1955	1,161	215	946	371	575
1956	1,299	210	1,089	530	559
1957	1,193	225	968	630	338
1958	1,098	220	878	532	346
1959	1,254	225	1,029	537	492
1960	1,214	175	1,039	618	421
1961	1,175	150	1,025	560	465
1962	1,203	120	1,083	564	519
1963	1,241	110	1,131	544	587
1964	1,209	90	1,119	516	603
1965	1,077	70	1,007	471	536

¹Represents consumption requirements minus farm slaughter.

²Represents the difference between requirements from commercial slaughter and marketings.

APPENDIX B

Appendix B, Table 1. Feed costs for selected swine rations.¹

Ingredient	Price		Ration		
	Unit	\$	16% Pounds	14% Pounds	12% Pounds
Corn	Bu.	1.34	1,507	1,629	1,739
Soybean meal (44%)	ton	74.67	440	330	220
Deflourinated rods phosphate	ton	62.00	28	14	18
Ground limestone	ton	20.00	12	14	12
Trace mineralized salt	ton	55.00	10	10	10
Vitamin and anti-biotic mix	3 lbs.	2.50	3	3	3
Total	-	---	2,000	2,000	2,000
Cost of ingredients	\$	ton	56.20	54.58	53.16
Grinding, mixing and delivery	\$	ton	5.00	5.00	5.00
Total cost	\$	ton	61.20	59.58	58.16

Source: Miss. Exp. Bul. 628, **Cost of Producing Hogs in Confinement**, October, 1961, corn and soybean meal prices for 5-year period 1960-65 on basis of bulk deliveries to Jackson. Other prices are on current basis.

¹Pig creep ration was considered to be purchased from feed mill already mixed for \$140 per ton because of small quantity required.

Appendix B, Table 2. Number 2 yellow corn prices at Jackson and St. Louis, 1960-65.

Year	Jackson	St. Louis	Difference
		(Dollars per bushel)	
1960	1.31	1.12	.19
1961	1.29	1.16	.13
1962	1.28	1.16	.12
1963	1.39	1.28	.11
1964	1.39	1.28	.11
1965	1.41	1.33	.08
Average	1.34	1.22	.12

Source: Jackson prices from **Grain Market News**, Federal-State Market News Service, weekly series, Cleveland, Mississippi; St. Louis, **Grain Market News**, USDA, Hyattsville, Maryland, weekly series.

Appendix B, Table 3. Investment requirements¹ for feeder pig production for selected size enterprises.

Item	Size of enterprise	
	50 sows	100 sows
Facilities:		
Farrowinghouse and nursing pens	4,240	7,395
Pasture sheds	256	512
Boar sheds	94	190
Fencing -	494	771
Water pipe ² -	216	260
Feeders -	344	651
Waterers -	191	355
Heat lamps -	19	32
Total facilities	5,854	10,166
Breeding stock:		
Sows -	2,500	5,000
Boars -	150	300
Total breeding stock	2,650	5,300
Total investment (excluding land)	8,504	15,466

Source: Miss. Agri. Exp. Sta. Bul. 628, **Cost of Producing Hogs in Confinement**, October, 1961.

All facility costs were adjusted upward 5 percent to reflect rising prices.

¹Excludes land.

²Because of the small quantity of water required, it was assumed the existing water system on most farms would be adequate.

Appendix B, Table 4. Annual costs of producing feeder pigs for selected size enterprises, 8 pigs saved per litter, 2 litters, per year.

Item	Size of enterprise	
	50 sows	100 sows
Investment costs: ¹		
Depreciation:		
Housing -	205	366
Equipment -	77	141
Fencing -	25	39
Water pipe	14	17
Interest on investment	279	519
Total -	600	1,082
Operating costs.		
Feed: ²		
Pigs — 18% protein	1,260	2,520
Sows — 14% protein	4,013	8,025
Boars — 14% protein	131	261
Repairs ¹ -	234	407
Veterinary and medicine	852	1,704
Electricity -	128	256
Total -	6,618	13,173
Total costs ³	7,218	14,255
Cost per pig ³	9.02	8.91

Source: Miss. Agri. Exp. Sta. Bul. 628, **Cost of Producing Hogs in Confinement**, October, 1961.

¹Facility costs including repairs were adjusted 5 percent upward to reflect changes in the price level.

²Adjusted to reflect current ingredient prices; corn and soybean meal prices are Jackson prices for the period 1960-65.

³Excluding labor and interest on land.

Appendix B, Table 5. Investment requirements¹ for feeding selected numbers of hogs annually.

Item	Number fed annually	
	800	1,600
	(dollars)	
Finishing pens	4,032	7,560
Feed storage bins	420	840
Feeders	504	945
Waterers	143	268
Water system ²	1,115	1,115
Total	6,214	10,728

Source: Miss. Agri. Exp. Sta. Bul. 628, **Cost of Producing Hogs in Confinement**, October, 1961.
 All facility costs were adjusted upward 5 percent to reflect rising prices.

¹Excludes land.

²300 feet of drilling and casings; pump and 120-gallon tank.

Appendix B, Table 6. Costs of finishing selected numbers of hogs to 200-pound weights with a 3.5 feed conversion ratio.

Item	Number fed annually	
	800	1,600
	(dollars)	
Investment costs: ¹		
Depreciation:		
Housing	161	302
Equipment	81	155
Water system	70	70
Interest on investment	155	268
Total	467	795
Operating costs:		
Feed ²	13,287	26,573
Repairs ¹	249	429
Electricity for pumping water	13	26
Total	13,549	27,028
Total costs ³	14,016	27,823
Costs per hog ³	17.52	17.39

Source: Miss. Agri. Expt. Sta. Bul. 628, **Cost of Producing Hogs in Confinement**, October, 1961.

¹Facility costs including repairs were adjusted 5 percent upward to reflect changes in the price level.

²Adjusted to reflect current ingredient prices; corn and soybean meal prices are Jackson prices for the period 1960-65.

³Excludes land and labor charges.

Appendix B. Table 7. Hog prices received by Mississippi and Iowa farmers, 1960-65.

Year	Iowa	Mississippi	Difference
	(dollars per hundredweight)		
1960	15.30	14.20	1.10
1961	16.50	15.80	.70
1962	16.20	15.80	.40
1963	14.80	14.70	.10
1964	14.60	14.60	.00
1965	20.79	19.26	1.53
Average	16.37	15.73	.64

Source: 1960-64, Agricultural Prices Annual Summaries; 1965, simple average of monthly Agricultural Prices, USDA.

Appendix B, Table 8. Costs of production and returns to labor and management for selected size hog enterprises in Mississippi, 1960-65.

Year	50 sows 800 feeders		100 sows 1,600 feeders	
	Cost	Net returns	Cost	Net returns
		\$/cwt.		
1960	13.14	1.06	13.01	1.19
1961	13.03	2.77	12.90	2.90
1962	12.98	2.82	12.85	2.95
1963	13.57	1.13	13.44	1.26
1964	13.57	1.03	13.44	1.16
1965	13.67	5.59	13.55	5.71
Average 6 years	13.33 ¹	2.40	13.20 ¹	2.53
Per hog	25.66	4.80	36.40	5.06

¹These costs estimates are slightly higher than those contained in other tables because of rounding error associated with rounding the price of corn.

APPENDIX C

Appendix C, Table 1. Typical farm enterprise organizations and associated incomes, by farm size, full-time Clay-Hills farms, Mississippi, 1961.

Item	Unit	Size of farm		
		Small	Medium	Large
Land: Total	acre	43	117	325
Cropland	acre	(18)	(39)	(75)
Bottom	acre	9	24	46
Terrace	acre	1	4	3
Rolling	acre	8	11	26
Open native pasture	acre	10	26	67
Woodland	acre	14	50	181
House and lot	acre	1	2	2
Crops: Cotton	acre	5.1	7.5	14.3
Corn	acre	8.9	19.3	34.8
Hay ¹	acre	4.0	12.3	25.8
Livestock: Workstock	No.	2	1	1
Cattle	A.U.	4.8	12.8	26.7
Investment: Total	Dol.	5,887	16,488	40,973
Land	Dol.	3,993	11,123	30,708
Mach. & equip. ²	Dol.	720	2,852	5,220
Livestock	Dol.	1,174	2,513	5,045
Labor: Operator				
available	Hours	2,640	2,640	2,640
utilized	Hours	1,073	1,998	1,520
Hired	Hours	---	487	1,235
Net cash income ³	Dol.	1,043	1,857	3,644
Returns to land, labor, & mgt. ⁴	Dol.	1,016	1,762	3,461

Source: Adapted from Crecink, J. C. and McLaughlin, A. L., **Increasing Incomes of Farm Families Through Farm Adjustment**, Clay-Hills of Mississippi, Miss. Agri. Expt. Sta. AEc. M. R. No. 44, March, 1965.

¹Hay meadows were also used for grazing.

²Depreciable items at one-half original investment.

³Cash receipts minus cash expenses.

⁴Non-cash items, such as rental value of house and value of farm products consumed in the home have not been taken into account. However, it has been estimated that in 1958 the full-time farm family used farm products (prerequisites) in the home valued at \$413 exclusive of the rental value of the house. The actual rental value of the house may be small, estimated to be between \$180 and \$240 per year in 1958, but alternatively the rental value might be much higher. See Miss. Agri. Expt. Sta. AEc. M. R. No. 29, November 1960.

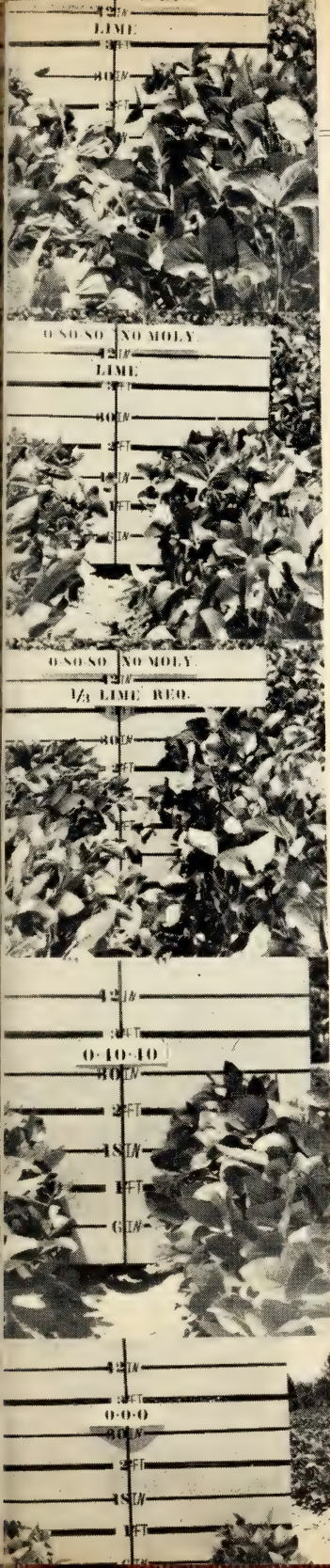
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Fertilizing Soybeans In the Hill Section of Mississippi

By

J. L. ANTHONY



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SUMMARY AND CONCLUSION

Phosphorus and Potassium Rate Studies

Experiments using different rates of phosphorus and potassium were conducted at the North Mississippi, Pontotoc Ridge-Flatwoods, Northeast Mississippi and Black Belt Branch Experiment Stations during the period 1962-1966. The soil series represented are: Grenada, Atwood, Iuka and Tilden, and Brooksville. These soils were low in phosphorus and ranged from medium to low in potassium. Soil reaction (pH) values ranged from 5.6 to 6.6.

All experiments were conducted over a five-year period. Due to sale of property the experimental sites at the Northeast Mississippi Branch Station were changed from the Iuka to Tilden soil series in 1966. When needed, lime was applied in amounts required for a soil pH of 6.0 to 6.5. Additional treatments of fritted trace elements (FTE) were also employed at all locations (See FTE Table 1).

At one location on an Atwood soil, nitrogen was applied as a side dressing (100 lbs. N/acre, from urea ammonium nitrate solution) when soybeans were in early bloom stage. At the Black Belt Station during the crop year 1962 forage yields were taken from one half of each plot to evaluate the response of soybean forage to various rates of phosphorus and potassium. Oven dry forage yields and feed analysis of the soybean hay was used as the criteria for measurement.

Soil test and rainfall data are included in this report as additional information to help analyze and interpret the yield data.

In general soybeans responded more to phosphorus than to potassium. The increase from phosphorus varied from 0-22 bushels per acre on the Atwood and Brooksville soils and 8 and 6, respectively, on the Grenada and Iuka-Tilden soils for the 0-80-40 treatment. On all soil types except Atwood silty clay loam, soybeans yields were in-

creased for the various rates of phosphorus and in most cases yields increased as rates of phosphorus increased.

Soybean yields were increased 3, 4 and 5 bushels (on Grenada soil) and 3, 5 and 7 bushels (on Iuka-Tilden soils) per acre for the 20, 40 and 80 pounds K_2O rates, respectively. Little or no response of soybeans to potassium was obtained on Atwood or the Brooksville soils. However, there was an increase of 2 to 5 bushels per acre for the nitrogen treatments on the Atwood soil.

On the Brooksville soil soybean forage yields were increased as the rates of phosphorus increased. The percent phosphorus, crude fat and protein in the soybean hay were essentially the same for the several phosphorus rates.

Residual Value of Phosphorus

An experiment was initiated in 1964 and continued in 1965 on a Brooksville clay soil to evaluate the response of soybeans to residual phosphorus. It followed a similar experiment using corn as the test crop during 1962 and 1963. Preplant fertilizers from the same source and amounts of phosphorus but only 60 pounds of potassium per acre were added to one half of each plot. The remaining one half received no additional fertilizers for the two-year period to study the residual effect of phosphorus applied to corn on the production of soybeans. From results of this two year test it is evident that annual applications of at least 45 pounds phosphorus per acre were necessary to build up the phosphorus status of the soil enough to increase soybean yields 10 bushels per acre from residual phosphorus.

Molybdenum and Lime Experiments

Studies to measure the effect of molybdenum and lime on the production of soybeans were conducted at seven locations during the period 1963-66. The soil series represented are: Grenada (North Miss.) Bude, Atwood, Til-

den, Brooksville, Prentiss, and Grenada (Central Miss.). The soils were slightly acid to strongly acid. With the exception of the Brooksville soil (pH 6.2), all soils were limed (dolomitic lime broadcast 1963 only) at rates required to raise soil pH to total lime requirement (pH 6.5), 1/3 and 2/3 of total lime requirement. The 1/6 total lime requirements rate was drilled annually at seeding time.

On the Brooksville soil, dolomitic limestone was drilled annually at the rate of 500 pounds per acre on each lime plot (8 rows). The remaining 8 rows received no lime. All plots were seeded to Lee soybeans, but to one half of each plot the seed were molybdenized with $\frac{1}{4}$ oz. molybdenum (39% active ingredient) per acre. Annual application of 0-80-80 was drilled at seeding time on all locations.

Molybdenum increased soybean yields significantly for the no lime, drilled lime, and low broadcast rates. The increase was greatest on the unlimed

plots and diminished as the lime rates were increased, although, in 1965 and 1966 there appeared to be use for the molybdenum with the higher rates of lime. The yield response of soybeans to lime without molybdenum was very similar to that of molybdenum without lime. However, the combination of lime and molybdenum appears to be the best approach to higher soybean yields.

Soil tests showed the pH of most of these soils increased as the rate of lime increased. Increased rates of lime usually raised the soil pH level in proportion to the amounts of lime applied. After 4 years cropping pH values were usually reduced below the original pH level and in proportion to amounts of lime applied.

The average rainfall during the growing seasons was for the most part nearly adequate, and fairly well distributed over the growing season. However, low rainfall reduced soybean yields on the Atwood soil three of the four years.

Fertilizing Soybeans In the Hill Section of Mississippi

INTRODUCTION

Until recently soybeans have not been widely grown in the hill section of Mississippi but this situation is changing rapidly.

Nation wide soybeans have become a 2.5 billion dollar crop and a major U. S. export. In 1966, farmers of the nation harvested 36,644,000 acres of soybeans, a substantial increase over a previous 5-year (1960-64) average of 27,535,000 acres. Per-acre yields have not increased so dramatically. The all-time U. S. high was 25.4 bushels in 1966, compared with a 5-year average of 24.0 bushels per acre.

Mississippi harvested 1,797,000 acres of soybeans in 1966, which is more than 50 percent above the 1960-64 average of 1,131,000 acres. The yield per acre for 1966 was 24.0 bushels, 3.6 bushels above the 5-year average for 1960-64. The Mississippi crop was worth more than 100 million dollars in 1966.

Along with this new emphasis on the crop there is a definite need for additional research in soybean technology from seeding to harvest. The processes in the development of the soybean plant which limits productivity are not known. The cause of the yield barrier has not been determined. However, there are certain known requirements for higher yields, one of which is fertility. Soybeans are often grown on acid soils without liming and frequently the crop is unfertilized.

In the period 1962-1966 numerous fertilizer, lime and molybdenum experiments were conducted with soybeans as the test crop by the Mississippi Agricultural Experiment Station in cooperation with the Branch Stations. It is the purpose of this report to present results from these experiments.

Field experiments comparing rates of $P_{2}O_{5}$ and $K_{2}O$ for soybeans were conducted at four Branch Experiment Stations. The soils were common to three soil areas (Brown Loam, Coastal Plain, and Black Land). The fertilizer treat-

ments were arranged in a randomized block with rates of phosphorus as one experiment and rates of potassium as another, each having five replications. An additional treatment of micronutrients FTE was also employed at all locations. Dolomitic limestone where needed was applied in amounts required to raise soil pH to 6.5. Inoculated Lee soybeans were seeded at the rate of 45 pounds per acre about 10 seed per foot of row at all locations.

One other experiment comparing rates of phosphorus was conducted for one year (1966) at the Black Belt Branch Experiment Station. The fertilizer treatments were arranged in a randomized block with 6 replications. A no phosphorus treatment was also employed.

As a rule legumes do not respond to direct applications of nitrogen fertilizers. However, if the symbiotic bacteria living in the root nodules of the legume cannot manufacture enough nitrogen for maximum production, some additional nitrogen could be helpful especially during bloom and pod set. This problem was studied at one location on Atwood silty clay loam soil pH 6.0.

In addition to these trials the residual value of phosphorus for soybean production was studied at one location on a Black Land soil. This experiment followed two years research with various rates and sources of phosphorus for corn production. A split plot design was used to evaluate the response of soybeans to residual phosphorus.

Fertilizers containing fritted trace elements which included molybdenum were tested under field conditions in Mississippi in 1962 with little success. However, 1962 research reported by Parker and Harris, Georgia Experiment Station Agronomists, showed significant increased soybean yields due to molybdenum treated seed planted on acid soils. The 1963 observational study

reported by B. C. Hurt, Jr., Supt. Pontotoc Branch Experiment Station, also shows increased yields of 29% and 47% due to seed treated with molybdenum on two acid soils (pH 5.4).

This and other work has led to more extensive research with this micronutrient.

The effect of molybdenum and lime on the production of soybeans was studied at seven locations over a 4-year period (1963-66) on soils common to those found in North and Central Mississippi.

The experimental design was split plot, the main plots were lime rates and the sub plots molybdenum. There were 6 replications. Annual applications of 0-80-80 were drilled at seeding time at all locations.

Throughout the bulletin the following symbols are used to designate levels of the available P_2O_5 and K pounds per acre.

Symbols

L—=very low

L =low

L+=low

P_2O_5

(0 to 31 lbs.)

(35 to 63 lbs.)

(67 to 102 lbs.)

Symbols

L—=very low

L =low

L+=low

K

(0-100)

(101-160)

(161-234)

The beneficial effect on plant growth from application of lime to acid soils has been observed and studied for many years. However, it was not until 1930 that the biological importance of molybdenum was first realized.

Molybdenum is a trace element. It is one of the seven micronutrients recognized as essential to the growth and development of higher plants.

No other soil treatment equals lime in economy and effectiveness in its unique roles, but there is another function of lime that can often be accom-

plished more cheaply and as effectively by other means. This function is to apply the trace element molybdenum. Molybdenum is required for the reduction of nitrates in the leaves of all plants and for nitrogen fixation in the root nodules of legumes.

Factors affecting the availability of molybdenum in the soils are:

1. Geological origin of the soil.
2. Age of soil.
3. Acidity or pH of soil.
4. Applications of other materials containing minute amounts of molybdenum.

Field experiments were initiated in the spring of 1963 and continued through 1966 by liming a Grenada silt loam, Bude very fine sandy loam, Atwood silty clay loam, Tilden fine sandy loam, Brooksville clay, Prentiss fine sandy loam, and Grenada silt loam (Lower Brown Loam Area). The experiments are located at the following Branch Experiment Stations: North Mississippi, Pontotoc Ridge-Flatwoods, Northeast Mississippi, Black Belt, Coastal Plain, and Brown Loam.

At all locations except the Black Belt Branch Station various rates of dolomitic limestone were applied broadcast (1963 only) in amounts required to raise the soil pH to 6.5 (total lime requirement) and amounts equal to 1/6, 1/3 and 2/3 of the total lime requirement. The smallest rate, 1/6 total lime requirement, was drilled annually at seeding time. At the Black Belt Station lime was drilled annually at the rate of 500 lb./acre to 1/2 of each plot. A no-lime treatment was also employed. The experimental design was a split plot with six replications. A uniform application of 0-80-80 was applied annually at seeding time.

Lee soybeans were seeded to all plots at the rate of 10 seed per foot of row or 45 lbs. per acre, molybdenized seed (1/4 oz. 38% active ingredient per acre) to 1/2 of each limed and no-lime plot.

Soil samples were taken from each plot (six replications) at all locations about 5 months (August) after the lime

was applied in 1963. Additional soil samples were taken in 1964 and 1965 from 3 of the 6 replications, and from each treatment in the 6 replications in

1966. Lime requirements and pH readings were determined for each sample at the soil testing laboratory, State College.

PHOSPHORUS AND POTASSIUM RATES EXPERIMENTS

Rate Of P_2O_5 and K_2O Experiment On Grenada Silt Loam. (pH 5.8, 1966)

Phosphorus and potassium rates tests were conducted for the 5-year period on Grenada silt loam (Brown Loam Soil) at the North Mississippi Branch Experiment Station at Holly Springs. Composite samples of surface soil collected before the experiment began tested as follows: Surface soil pH 6.2, available P_2O_5 17 pounds and K 129 pounds per acre. No lime was added.

Results (Table 1) show a 5-year average yield of 24 bushels per acre without fertilizer, 26 bushels with potash but without phosphate and 30, 31 and 34 bushels, respectively, for the 20, 40 and 80 pounds of P_2O_5 rates where potash was applied at 40 lbs. per acre. The increases were 4, 5 and 8 bushels, respectively, (significant at .01% probability level).

The 1966 soil tests showed a slight decrease in pH value (5.8), available

soil phosphorus (no phosphate treatment, 16 lbs. an acre) and a slight increase in soil phosphorus of (20, 21 and 28 pounds an acre) for the 20, 40 and 80 pounds P_2O_5 rates. This indicates that under the present cropping system even larger applications of phosphorus and additional applications of lime are required to build up the available soil pH and phosphorus to medium or high levels.

Yields (5 year average) without potash were 28 bushels per acre, and 31, 32 and 33 bushels for the 20, 40 and 80 pounds K_2O rate, an increase of 3, 4 and 5 bushels per acre (significant at .01% probability level). The 40-pound P_2O_5 + FTE yield was 33 bushels per acre, a 1 bushel increase for the FTE treatment (not significant).

The 1966 soils test showed a slight decrease in available soil potassium (no potassium treatment, 96 pounds per acre) and a slight increase of soil potas-

Table 1. Fertilizer requirements for soybean production, North Mississippi Branch Station, Holly Springs, Mississippi. Soil type: Grenada Silt Loam pH 5.8, 1966.

Fertilizers under test	*Soil test data 1966	Soybean yields bushels per acre					
		1962	1963	1964	1965	1966	5 yr. ave.
	P ₂ O ₅						
0-0-0	16L	38	24	20	19	18	24
0-0-40	16L	39	29	20	22	20	26
0-20-40	20L	38	31	26	27	26	30
0-40-40	21L	40	33	26	30	27	31
0-80-40	28L	43	35	29	34	31	34
	.05	3 bu.	3 bu.	3 bu.	2 bu.	4 bu.	3 bu.
LSD	.01	NS	5 bu.	4 bu.	3 bu.	5 bu.	4 bu.
CV		5.5%	6.8%	7.9%	5.4%	12.3%	
	K						
0-40-0	96L	40	29	23	24	24	28
0-40-20	110L	43	34	26	26	25	31
0-40-40 + FTE	108L	46	33	30	29	26	33
0-40-40	118L	43	33	28	28	26	32
0-40-80	119L	46	34	31	29	27	33
	.05	NS	4 bu.	3 bu.	2 bu.	2 bu.	3 bu.
LSD	.01	NS	NS	4 bu.	3 bu.	3 bu.	4 bu.
CV		8.5%	7.4%	3.5%	6.7%	7.5%	

FTE = Fritted trace elements 25 lbs. per acre.

5.6% FeO_3
15.4% MnO_2
2.5% CuO
5.0% ZnO
9.0% D_2O_3
.2% MgO_3

*Levels of and available P_2O_5 and K_2O per acre.

Table 2. Weekly rainfall for the 4-year period 1963-66 and for the months of June, July, August and September, North Mississippi Branch Station, Holly Springs, Mississippi.

	Inches of rainfall per week			
	1963	1964	1965	1966
JUNE				
1-7	.00	.07	.71	.45
8-14	.00	.11	1.05	.00
15-21	1.26	.00	.17	.00
22-28	.51	2.30	.02	.00
29-30	.15	.90	.00	.50
Total	1.92	3.38	1.95	.95
JULY				
1-7	.57	.52	1.11	.23
8-14	1.28	3.91	1.54	1.30
15-21	2.37	.05	.00	.40
22-28	.43	.00	.17	.00
29-31	.12	.43	.00	.06
Total	4.67	4.91	2.82	1.99
AUGUST				
1-7	.43	.38	1.10	.41
8-14	.34	1.58	.58	1.68
15-21	.08	3.78	.08	.42
22-28	.53	.62	1.19	1.07
29-31	1.11	.00	.00	.00
Total	2.49	6.36	2.95	3.48
SEPTEMBER				
1-7	1.73	.00	.97	.40
8-14	.00	.00	2.66	.47
15-21	.00	.81	.62	.51
22-28	.03	4.61	.39	.16
29-30	.00	.10	.65	1.95
Total	1.76	5.52	5.29	3.49
Total 4 months	10.84	20.16	13.01	9.91

sium (110, 118 and 119 pounds per acre) for the 20, 40 and 80 pound K_2O rates.

The average rainfall for July was 3.58 and for August 3.82 inches (Table 2) during the 4 year period. The rainfall was fairly well distributed throughout both months, but was slightly less than amount required for optimum production.

Rates Of P_2O_5 And K_2O Experiment On Atwood Silty Clay Loam pH 6.0 (1966)

An experiment similar to that on Grenada silt loam was conducted on Atwood silty clay loam (Coastal Plain Soil) at the Pontotoc Ridge Branch Experiment Station, Pontotoc, Mississippi, for 5 years (1962-66). In 1962, 1965 and 1966 nitrogen as urea-ammonium nitrate solution was applied as a side dressing to one half of each plot. One hundred pounds of N per acre was applied at bloom and pod set to evaluate the need for additional nitrogen at this stage of growth. Soil tests made after the first year of the experiment showed the surface soil had a pH of 5.2 and 88 and 227 pounds per acre of available phosphorus and potassium, respectively.

Lime was then added in amount required to raise the soil pH to 6.5.

Yields and the 1966 soil test data are shown in Table 3. They show no significant yields difference (5-year average) for any of the rates of phosphorus FTE or potash tested, however, there was a significant difference in yield between nitrogen and no nitrogen. The 3-year average increase ranged from 2 to 5 bushels per acre (significant at .05% probability level) for nitrogen, among the various P_2O_5 and K_2O treatments. Nitrogen is not recommended for soybean production in the state, but more research is needed along this line.

The pH in 1962 was 5.2, a low value unfavorable for the best bacterial action in the manufacturing of nitrogen from the soil air. This is perhaps responsible for the large increase in yields for the applied nitrogen during the year 1962. In 1963, lime was applied to raise the pH to 6.5 and by 1966 it was down to 6.0.

The five-year average yield was 29 bushels of soybeans per acre without fertilizer, 30 bushels without phosphate,

and 30, 30 and 30 bushels per acre for the 20, 40 and 80 pound P_2O_5 rates. No increased yields were obtained for any rate of phosphorus. Yields without potash were 26 bushels per acre, and 27, 29 and 27 bushels per acre, respectively, for the 20, 40 and 80 pound K_2O rates. The 40-pound P_2O_5 plus FTE treatment yielded 27 bushels per acre with no increase for the FTE treatment.

The available soil phosphorus and potassium were slightly increased for the various rates of P_2O_5 and K_2O . However, there appeared to be enough of both in the soil to produce maximum yields under this cropping system. The available soil phosphorus and potassium in this Atwood silty clay loam was much higher than the test for the Grenada silt loam soil at Holly Springs.

Average rainfall for July was 4.38 inches and for August 3.47 (Table 4). With the exception of July 1963 and

August 1966 when the rainfall was 7.19 and 5.30 inches, respectively, the monthly distribution of rainfall was fairly good. However, total rainfall for the growing seasons was less than is required (15 to 20 inches) for optimum production three of the 4 years.

Rates Of P_2O_5 And K_2O Experiment On Iuka Fine Sandy Loam pH 5.6 (1965) And Tilden Fine Sandy Loam pH 5.6 (1966)

Phosphorus and potassium rates test were conducted for the 4-year period (1962-65) on Iuka fine sandy loam and for one year, 1966, on Tilden fine sandy loam (Coastal Plain Soil) at the Northeast Mississippi Branch Experiment Station at Verona. Composite surface soil samples collected before the experiment began tested as follows: Soil pH 5.6, Available P_2O_5 , 52 pounds and K 68 pounds per acre.

Table 3. Fertilizer requirements for soybean production, Pontotoc Ridge-Flatwoods Branch Station, Pontotoc, Mississippi. Soil type: Atwood silty clay loam pH 6.0, 1966.

Fertilizers under test	*Soil test data 1966	Soybean yields bushels per acre							
		1962	1963	1964	1965	1966	5-yr. ave.	3-yr. ave.	
P ₂ O ₅									
0-0-0		69L+	16	44	22	29	32	29	26
0-0-0 + N**		69L+	25	—	—	34	34	—	31
0-0-40		70L+	17	44	26	31	33	30	27
0-0-40 + N		70L+	22	—	—	34	35	—	30
0-20-40		70L+	17	45	28	29	31	30	26
0-20-40 + N		70L+	22	—	—	36	36	—	31
0-40-40		73L+	18	42	28	31	33	30	27
0-40-40 + N		73L+	22	—	—	35	35	—	31
0-80-40		120M—	18	42	26	32	33	30	28
0-80-40 + N		120M—	23	—	—	38	35	—	32
.05	**3 bu.		NS	NS	5 bu.	NS	4 bu.	5 bu.	3 bu.
LSD .01	4 bu.		NS	NS	5 bu.	NS	6 bu.	6 bu.	4 bu.
CV			11.5%	6.1%	11.7%	6.2%	10.3%		
K									
0-40-0		178L+	15	37	22	25	29	26	23
0-40-0 + N**		178L+	20	—	—	29	31	—	27
0-40-20		185L+	17	39	24	26	28	27	24
0-40-20 + N		185L+	21	—	—	28	29	—	26
0-40-40		203L+	17	39	24	30	28	28	25
0-40-40 + N		203L+	21	—	—	30	32	—	28
0-40-40 FTE		208L+	16	40	24	26	30	27	24
0-40-40 FTE + N		208L+	20	—	—	29	32	—	27
0-40-80		231L+	16	38	26	26	30	27	24
0-40-80 + N		231L+	19	—	—	28	32	—	26
.05	**2 bu.		2 bu.	NS	NS	3 buNS	4 bu.	4 bu.	2 bu.
LSD .01	3 bu.		NS	NS	NS	4 buNS	5 bu.	5 bu.	3 bu.
CV			8.5%	7.6%	11.7%	8.0%	10.6%		

*Levels of and available P_2O_5 and K_2O per acre.

**100 lbs. N/Acre from urea ammonium nitrate solution, applied as a side dressing when soybeans were in early bloom stage.

FTE = Fritted trace element 25 lbs. per acre.

5.6% Fe_2O_3
15.4% MnO_3
2.5% CuO
5.0% ZnO
9.0% B_2O_3
2.0% MgO

Table 4. Weekly rainfall for the 4-year period 1963-1966 and the months of June, July, August and September; Pontotoc Ridge Flatwoods Branch Station, Pontotoc, Miss.

	Inches of rainfall per week			
	1963	1964	1965	1966
JUNE				
1-7	.00	.00	.41	1.35
8-14	.00	.00	.93	.12
15-21	1.38	.00	.00	.10
22-28	.92	.00	.41	.00
29-30	.00	2.08	.00	.17
Total	2.30	2.08	1.75	1.74
JULY				
1-7	.23	1.76	.83	.34
8-14	2.96	1.88	.57	.20
15-21	2.64	.13	.07	2.08
22-28	.38	.78	.70	.00
29-31	.73	.00	.00	.00
Total	7.19	4.55	3.17	2.62
AUGUST				
1-7	.63	1.20	.12	.10
8-14	.55	.83	.99	3.88
15-21	.00	1.14	.37	.77
22-28	.90	.00	1.61	.30
29-31	.23	.00	.04	.25
Total	2.31	3.17	3.13	5.30
SEPTEMBER				
1-7	2.05	.00	.78	.13
8-14	1.05	.00	1.42	.68
15-21	.00	.10	.00	.00
22-28	.53	2.10	.74	.00
29-30	.00	1.10	.91	.93
Total	3.63	3.30	3.13	1.74
Total 4 Months	15.43	13.10	11.18	11.40

Yields, and the 1966 soil test data are shown in Table 5. The 1963 crop was destroyed by flood and no harvest was made. The 4-year average yield was 24 bushels per acre without fertilizer, 28 bushels without phosphate, and 32, 34 and 34 bushels per acre for the 20, 40 and 80 P_2O_5 rate. The increases were 4, 6 and 6 bushels (significant at .01% level). The 1965 soil test (last year of the experiment at this location) showed a slight decrease in soil pH (5.6) and available phosphorus (52 pounds per acre) and a slight increase to 80 pounds per acre for the 80 pounds P_2O_5 rate. The 1966 soil test (a new location) showed pH value of 5.6 and available soil phosphorus (46 pounds per acre) a slight increase to 57, 63 and 80 pounds an acre for the 20, 40 and 80 pounds of P_2O_5 rate.

Four-year average yield without potash was 25 bushels an acre, and 28, 30 and 32 bushels for the 20, 40 and 80 pound K_2O rates. The increases were 3, 5 and 7 bushels (significant at .05% level). The 40-pound P_2O_5 + FTE yield was 31 bushels per acre, a 1 bushel increase for the FTE treatment (not sig-

nificant). The 1965 soil test showed a slight decrease in pH (5.6) and available potash (68 pounds an acre) an increase to 100 pounds per acre for the 80 pounds K_2O rate. The 1966 soil test showed a pH of 5.6 (a new location and available soil potassium of 112, 152 and 165 pounds an acre, respectively, for the 20 40 and 80 pound K_2O rates.

Average rainfall for July was 6.78 inches and for August 2.91 inches (Table 6) for the 4-year period. The July rains for the 4-year period were not too well distributed. In 1963 and 64 rainfall was somewhat excessive, 8.84 and 12.24 inches, respectively. The 1965 rainfall for July was only 1.61 inches, and 4.44 inches for the same month in 1966. August rainfall was fairly well distributed, but total amounts were not sufficient for maximum soybean yields.

Rates Of P_2O_5 and K_2O Experiment on Brooksville Clay pH 6.3 (1966)

An experiment similar to the ones discussed previously was conducted on Brooksville Clay (Black Land Soil) at the Black Belt Branch Experiment Sta-

tion at Brooksville, Mississippi, for the 5 years 1962-1966. Prior to initiation of this experiment the pH reading was 6.6. The available P_2O_5 was 4 pounds and K 180 pounds per acre. No lime was added since the pH was above 6.0.

Annual fertilizer applications were drilled at seeding time the first 4 years, and in the fall for 1966.

Yields and the 1966 soil test data are shown in Table 7. The 5-year average yield was 9 bushels of soybeans per

Table 5. Fertilizer requirement for soybean production, Northeast Mississippi Branch Station, Verona, Mississippi. Soil type: Iuka fsl (1962-64-65) pH 5.6 Tilden fsl 5.6 (1966).

Fertilizers under test	*Soil test data 1966	Soybean yields bushels per acre**				
		1962	1964	1965	1966	4-yr. ave.
	P_2O_5					
0-0-0	46L	27	26	27	16	24
0-0-40	45L	33	28	32	20	28
0-20-40	57L	38	31	32	27	32
0-40-40	63L	38	33	37	29	34
0-80-40	80L	38	32	35	30	34
LSD .05		5 bu.	3 bu.	4 bu.	2 bu.	4 bu.
LSD .01		6 bu.	4 bu.	6 bu.	3 bu.	5 bu.
CV		9.6%	8.6%	9.8%	8.4%	
	K					
0-40-0	125L	28	24	32	16	25
0-40-20	112L	33	26	34	19	28
0-40-40 + FTE	129L	37	29	36	22	31
0-40-40	152L	36	28	33	22	30
0-40-80	165L	39	30	35	22	32
LSD .05		4 bu.	4 bu.	5 bu.	5 bu.	4 bu.
LSD .01		6 bu.	6 bu.	7 bu.	7 bu.	6 bu.
CV		9.3%	13.2%	11.5%	18.1%	

*Levels of and available P_2O_5 and K per acre.

**1963 experiment destroyed by flood.

FTE = Fritted trace element 25 lbs. per acre.

5.6% Fe_2O_3

15.4% MnO_2

2.5% CuO

5.0% ZnO

9.0% B_2O_3

.2% MO_3

Table 6. Weekly rainfall for the 4 years 1963-66 for the months of June, July, August and September, Northeast Mississippi Branch Station, Verona, Mississippi. Data taken from Tupelo Weather Station.

	Inches of rainfall per week			
	1963	1964	1965	1966
JUNE				
1-7	.00	.00	.50	.83
8-14	.06	1.17	.97	.03
15-21	5.36	.03	.12	.08
22-28	2.88	.00	1.14	.00
29-30	.00	.57	.00	2.20
Total	8.30	1.77	2.73	2.20
JULY				
1-7	.69	3.13	.38	.99
8-14	.98	5.86	.00	.02
15-21	5.48	.10	.27	3.13
22-28	.65	.53	.96	.00
29-31	1.04	2.62	.00	.30
Total	8.84	12.24	1.61	4.44
AUGUST				
1-7	.12	.81	.79	.45
8-14	.04	1.09	.09	2.20
15-21	.36	.69	1.04	.49
22-28	.00	.34	1.97	.00
29-31	.84	.00	.00	.32
Total	1.36	2.93	3.89	3.46
SEPTEMBER				
1-7	1.92	.00	.00	.02
8-14	.14	.00	1.47	.73
15-21	.00	.28	.07	1.37
22-28	.21	2.52	.69	.43
29-30	.00	1.23	1.22	.56
Total	2.27	4.03	3.45	3.13
Total 4 Months	20.77	20.07	11.68	13.23

acre, without fertilizer, 10 bushels without phosphate, and 21, 25 and 32 bushels per acre, respectively, for the 20, 40 and 80 pound P_2O_5 rates. The increases were 11, 15 and 22 bushels (significant at .01% level). The 40 pounds P_2O_5 + Mg. treatment produced 27 bushels per acre or a 2 bushel increase (not significant).

The 1966 soil test showed a slight decrease in pH (6.3) and about the same amount of available soil phosphorus (5 lbs. an acre) and a slight increase to 10, 14 and 33 pounds per acre for the 20, 40 and 80 pounds P_2O_5 rate. This indicates that under the present cropping system even larger applications of phosphorus are needed to build up the soil phosphorus to medium or high levels.

Yields (5-year average) without fertilizer were 18 bushels per acre, without potash, 28 bushels (significant at .01% level) and 30, 30 and 29 bushels per acre respectively for the 20, 40 and 80 pound K_2O rates (not significant). The 40-pound P_2O_5 + FTE treatment yielded 30 bushels per acre, with no increase for the FTE treatment.

Average rainfall for July was 5.13 inches and for August 4.72 inches (Table 8) during the 4-year period. The rainfall was fairly well distributed and was about the amount required for optimum soybean production.

Rates Of P_2O_5 Experiment On Brooksville Clay pH 6.8 (1966)

One other experiment was conducted on Brooksville clay (Black Land Soil) at the Black Belt Branch Experiment Station, Brooksville, Mississippi, for one year (1966). Soil test made before the experiment was started showed the surface soil had a pH of 6.8 and 20 pounds per acre of available phosphorus. No lime was added since the pH was above 6.5.

Soybean yields are shown in Table 9. The yields without phosphorus were 33 bushels per acre, and 37, 39 and 41 bushels for the 20, 40 and 80 pound P_2O_5 rates. The increases were 4, 6 and 8 bushels (significant at .01% level).

Some times farmers are undecided whether to harvest soybeans for hay (early bean set) or harvest later for grain. To evaluate the response of

Table 7. Fertilizer requirements for soybean production, Black Belt Branch Station, Brooksville, Mississippi, Soil type: Brooksville clay pH 6.3.

Fertilizers under test	*Soil test data 1966	Soybean yields bushels per acre					
		1962	1963	1964	1965	1966	5-yr. ave.
P ₂ O ₅							
0-0-0	5L—	13	11	11	6	5	9
0-0-40	5L—	13	13	11	7	6	10
0-20-40	10L—	18	26	22	18	19	21
0-40-40	14L—	19	32	27	23	26	25
0-40-40 + Mg (Sul-Po-Mg)	16L—	22	32	29	26	28	27
0-80-40	33L—	20	35	37	32	36	32
.05		3 bu.	3 bu.	4 bu.	3 bu.	3 bu.	3 bu.
LSD .01		4 bu.	4 bu.	5 bu.	4 bu.	4 bu.	4 bu.
CV		14.4%	8.2%	13.8%	13.9%	13.0%	
K							
0-0-0	*177L+	18	22	17	18	15	18
0-40-0	183L+	23	32	28	29	30	28
0-40-20	181L+	22	34	30	30	33	30
0-40-40	193L+	22	32	31	30	33	30
0-40-40 + FTE	197L+	23	34	30	32	33	30
0-40-80	197L+	22	32	29	31	31	29
.05		NS	5 bu.	5 bu.	5 bu.	3 bu.	5 bu.
LSD .01		NS	7 bu.	6 bu.	6 bu.	5 bu.	6 bu.
CV		16.9%	11.8%	15.2%	13.5%	10.2%	

*Levels of and available P_2O_5 and K per acre.

FTE = Fritted trace elements 25 lbs. per acre.

Mg = Magnesium

5.6% Fe_2O_3
15.4% MnO_2
2.5% CuO
5.0% ZnO
9.0% B_2O_3
.2% MOO_3

Table 8. Weekly rainfall for the 4-year period 1963-66 for the months of June, July, August and September; Black Belt Branch Station, Brooksville, Mississippi.

	Inches of rainfall per week			
	1963	1964	1965	1966
JUNE				
1-7	.00	.14	.31	.97
8-14	.00	1.53	1.14	.50
15-21	.33	.00	1.14	.23
22-28	1.51	.53	.88	.00
29-30	1.84	1.64	.00	.35
Total	3.68	3.84	3.47	2.05
JULY				
1-7	2.97	1.03	.53	.00
8-14	2.64	1.49	.62	.00
15-21	3.03	.53	.29	2.00
22-28	1.01	1.11	.65	.00
29-31	.18	.01	.00	2.44
Total	9.83	4.17	2.09	4.44
AUGUST				
1-7	.48	1.21	1.38	1.60
8-14	.37	.27	4.02	2.01
15-21	.76	3.92	.65	.47
22-28	.06	.04	.83	.62
29-31	.00	.00	.02	.17
Total	1.67	5.44	6.90	4.87
SEPTEMBER				
1-7	.19	.00	.15	.50
8-14	.00	.00	1.33	1.34
15-21	.00	1.25	.40	2.80
22-28	.24	.26	1.04	.00
29-30	.00	1.89	.19	.68
Total	.43	3.40	3.11	5.32
Total 4 Months	15.61	16.85	15.57	16.68

soybean forage to various rates of P_2O_5 and K_2O , forage yields were taken from one half of each plot in 1962 only. As the rates of phosphorus increases soybean forage yields also increased. (Table 10). The 80-pounds of P_2O_5 rate produced more than twice the amount of soybean hay produced on the no fertilizer treatment. The percent phosphorus, crude fat and protein in the forage were essentially the same for the various rates of phosphorus ranging from 0.10% to 0.12% phosphorus, 4.85

to 5.93 percent crude fat and 14.53 to 15.17 percent protein.

Table 9. Fertilizer requirements for soybean production; Black Belt Branch Experiment Station, Brooksville, Miss., 1966. Soil type: Brooksville Clay pH 6.8.

Fertilizers under test	Soybean yield bushels per acre
0-0-40	33
0-20-40	37
0-40-40	39
0-80-40	41
LSD .05	2 bu.
.01	3 bu.
CU	5.5%

Table 10. Fertilizer requirements for soybean hay production and feed analysis of the forage 1962; Black Belt Branch Station, Brooksville, Mississippi. Soil type: Brooksville Clay pH 6.2.

Fertilizer treatments	Dry forage yields lbs. per acre	Percent P	Percent crude fat	Percent protein
0-0-0	4043	.10	5.58	14.60
0-0-40	4852	.11	5.50	14.93
0-20-40	6718	.10	5.16	14.35
0-40-40	7091	.12	5.93	15.17
0-40-40 + Mg	7340	.11	5.76	15.01
0-80-40	8148	.10	4.84	14.73

RESIDUAL VALUE OF PHOSPHORUS EXPERIMENT

Residual Value of Phosphate On Brooksville Clay

Added phosphorus accumulates to some extent in soils. This occurs because only a small percentage of the phosphorus applied in fertilizers is removed in the harvested portion of the crop. Extent of accumulation depends on such factors as amounts of phosphorus added, amount lost by erosion, crop grown, and how much of the crop is removed from the land.

Loss by erosion and run-off has been recognized as an important factor in reducing phosphorus accumulation. The amount removed from the soil by the plants depends on the crop and the amount of growth removed. A cotton yield of 750 pounds of lint per acre removed about 22 lbs. P_2O_5 , 100 bushels of corn 35 pounds, and 50 bushels of soybeans, 40-pounds per acre.

The residual value of applied phosphates has been studied by many researchers who found that yields usually decline when phosphorus fertilization was discontinued. However, there was a residual effect that was in proportion to the amounts that had been added.

The availability of accumulated phosphorus for succeeding crops is of practical importance. Soil tests can be used to determine the amount of residual phosphorus in the soil, and from these tests phosphorus needs can be determined.

In the spring of 1962, an experiment was initiated and continued in 1963 using corn as the indicator crop on a Brooksville clay soil pH 6.6. By test, this soil was very low in available phosphorus and medium in potassium. The experimental design was a randomized block with 4 replications.

Fertilizer used in the experiment was

as follows: Commercial 13-13-13 containing ammonium phosphate-sulphate. Ammonium nitrate and muriate of potash sufficient to give 60 pounds of N and 72 pounds of K_2O per acre were mixed with the experimental fertilizer.

Experimental fertilizer was applied in amounts to supply 15, 30, 45 and 60 pounds available P_2O_5 per acre in 1962 and 1963. A no-phosphate treatment was also employed. An additional 60 pounds of N was applied annually as a top dressing in the spring. Corn was discontinued as the test crop after the 1963 year.

Soybeans were then used as the test crop. In the spring of 1964 and 1965, the same rates of P_2O_5 from the same source but only 60 pounds K_2O per acre were added to one-half of each plot, the remaining half received no additional fertilizers for the two-year period. Inoculated Lee soybeans were seeded to all plots to study the residual effects of phosphate applied to corn for the production of soybeans.

Table 11 shows soybean yields for the various rates of phosphorus for the years 1964 and 1965, and 2 year averages. These data show that as the rate of applied P_2O_5 increases yields also increase. As might be expected the response of soybeans to residual phosphate was greater in 1964 and 1965. However yield increases due to residual phosphate were very small until the 45 pound rate was reached. The 45 and 60 pound rates of residual P_2O_5 increased soybean yields 11 bushels per acre whereas the 45 to 60 pound rates of applied P_2O_5 increased yields 22 bushels per acre. Data in Table 12 show levels of and pounds per acre of available P_2O_5 for the years 1964 and 1965.

Table 11. Fertilizers and soybean yield bushels per acre (1964-65).

Rates of P_2O_5 per acre	Commercial 13-13-13 applied P_2O_5			Residual P_2O_5		
	1964	1965	2-year ave.	1964	1965	2-year ave.
15	26	24	25	21	10	16
30	32	24	28	20	17	19
45	37	32	35	28	19	24
60	37	35	36	28	20	24
0	13 bu. per acre					

Table 12. Soil test data for 1964 and 1965, fertilizers and levels of and available P_2O_5 lbs. per acre, (Commercial 13-13-13 source of fertilizer).

Rates of P_2O_5	Applied P_2O_5			Residual P_2O_5		
	1964	1965	2-year ave.	1964	1965	2-year ave.
0	3L—	10L—	6L—	2L—	6L—	6L—
15	8L—	12L—	10L—	3L—	8L—	5L—
30	13L—	15L—	15L—	5L—	7L—	6L—
45	13L—	21L—	17L—	5L—	7L—	6L—
60	13	41L—	27L—	5L—	8L—	7L—

For the most part, as the rates of P_2O_5 increased levels of and pounds per acre of available P_2O_5 also increased for applied phosphorus. However, as might be expected the amount of available phosphorus per acre for residual

phosphate was less than for applied P_2O_5 . There was a very good correlation between soybean yields and soil test data for applied phosphorus. Smaller differences were obtained from residual phosphates (Tables 10 and 11).

MOLYBDENUM AND LIME EXPERIMENTS

Molybdenum And Lime Experiment On Grenada Silt Loam

This molybdenum and lime rates test was conducted for 4-years on Grenada silt loam (Brown Loam Soil) at the North Mississippi and Brown Loam Branch Experiment Station, Holly Springs and Raymond, Mississippi. About the only differences between these test were location (North and Central Mississippi). The soil type, pH readings, lime requirements, fertility status, rainfall, and soybean yield data were essentially the same. The sources of molybdenum were different, however, the response to molybdenum was essentially the same, and there was no reason to believe that sources made any difference in production of soybeans. For the above reasons the two experiments for the most part will be discussed together.

Surface soil samples collected 5 months (1963) after the experiments had been initiated showed the following: The pH values were 4.7 and 4.8, respectively, for the Brown Loam and North Mississippi locations where no lime had been applied. The soil fertility status at both locations was medium in phosphorus and low minus in potash prior to fertilizer applications in 1963. By 1966, after annual applications of 0-80-80 fertilizer, the P_2O_5 and K_2O status increased to high and medium levels, respectively.

At both locations dolomitic lime was drilled at the rate of 1000 pounds an

acre (1/6 total lime requirement) at seeding time and broadcast at rates of 2000, 4000 and 6000 pounds an acre (1963 only). This amount was 1/3, 2/3 and the total lime requirement, respectively.

Yields for the various rates of lime with and without molybdenum and pH values are shown in Table 13. (For rainfall at the North Mississippi Station see Table 2). Table 13 shows a 4-year average yield of 27 bushels of soybeans an acre for molybdenum without lime (pH 4.8) an increase of 8 bushels per acre for molybdenum on the unlimed plots (significant at .01% level). The pH for the no lime plots were essentially the same during the 4-year period. The molybdenum treatments (4-year average) yielded 37, 36, 36 and 36 bushels per acre for the 1000 pounds lime drilled annually, the 2000, 4000 and 6000 pounds, respectively.

There was little or no response to molybdenum (4-year average yields) with any of the higher rates of lime. However, there was a slight response to molybdenum for the two smaller rates (1000 and 2000 pounds). The response to molybdenum for the higher rates (4000 and 6000 pounds per acre) was small for the last two years (1965-66), but greater than the response for the years 1963-1964. This may indicate that the soybean plants have used most of the soil molybdenum made available by the use of lime.

Table 13. The effect of Mo and Lime on the production of soybeans; North Mississippi Branch Station, Holly Springs, Mississippi.

Soil Type: Grenada Silt Loam, P₂O₅ H = 165 lbs. KL + 186 lbs.

Lime rate	pH value				Treat- ment	Yield bu. per acre				
	1963	1964	1965	1966		1963	1964	1965	1966	4-yr. ave.
No lime	4.8	4.8	4.9	4.8	Mo	37	35	36	33	35
Same	4.8	4.8	4.9	4.8	No Mo	30	24	27	26	27
1000 lbs. drilled lime	5.0	5.4	5.2	5.0	Mo	40	35	40	34	37
Same	5.0	5.4	5.2	5.0	No Mo	32	30	34	31	32
2000 lbs. L. (BC)	5.2	5.4	5.3	5.5	Mo	40	31	37	34	36
Same	5.2	5.4	5.3	5.5	No Mo	34	26	32	29	30
4000 lbs. L. (BC)	5.5	5.5	5.8	5.3	Mo	37	34	37	34	36
Same	5.5	5.5	5.8	5.3	No Mo	35	34	34	32	34
6000 lbs. L. (BC)	5.9	5.9	6.2	5.5	Mo	38	35	37	34	36
Same	5.9	5.9	6.2	5.5	No Mo	37	35	35	33	35
LSD .05						3 bu.	3 bu.	5 bu.	2 bu.	3 bu.
.01						4 bu.	4 bu.	7 bu.	3 bu.	4 bu.
CV						6.6%	4.1%	12.2%	6.6%	

Mo = Molybdenum, (BC) = Broadcast lime (Dolomite), Drilled = Lime drilled at seeding

time. (Dolomite).

Lime requirement (pH 6.5) 6000 lbs. per acre.

Lime without molybdenum (4-year average) produced yields as follows: 32, 30, 34 and 35 bushels per acre, respectively, for the 1000, 2000, 4000 and 6000 pounds per acre rate. An increase of 5, 3, 7 and 8 bushels per acre, respectively, for the various rates of lime (significant at .01% level). The no lime treatment yielded 27 bushels per acre.

Soil test showed the pH of this soil increased as the lime rates increased, but somewhat of a decrease in pH value over the 4-year period.

Yields for the various rates of lime with and without molybdenum and the pH values for the years 1963-1966 (Brown Loam Station) are shown in Table 14. These data are very similar to those shown in Table 13 (North Mississippi Branch Station) therefore they are not discussed in detail.

The 4-year average rainfall for July was 3.67 inches and for August 3.51 inches (Table 15). It was fairly well distributed throughout both months, and was about the amount required for optimum soybean production.

Molybdenum And Lime Experiment On Atwood Silty Clay Loam

A molybdenum and lime rates test was conducted for 4-years on Atwood Silty Clay Loam (Coastal Plain Soil) at the Pontotoc Ridge-Flatwoods Branch Experiment Station, Pontotoc, Mississippi. Surface soil samples collected prior to the initiation of the experiment

has a pH value of 5.4. The available P₂O₅ and K was 45 pounds and 294 pounds per acre, respectively. Dolomitic limestone was added in amounts of 2700 pounds per acre, the amount required to raise the soil pH to 6.5. At seeding time 1/6 (500 lbs.) of the total lime requirement was drilled annually. During the year of 1963 (only) the 1/3 (900 lbs.) the 2/3 (1800 lbs.) of the total lime requirement treatments (2700 lbs.) were broadcast and mixed with the soil. Annual applications of 0-80-80 were drilled at time of seeding.

Yields with and without molybdenum, and the pH values are shown in Table 16. The 4-year average yields of 15 bushels for the no lime (pH 5.2) no molybdenum treatment, and 21 bushels for the molybdenum-no lime treatment. An increase of 6 bushels per acre for the molybdenum (significant at .01% level). The molybdenum and lime treatments produced 22, 21, 21 and 21 bushels of beans per acre, respectively, for the 1/6, 1/3, 2/3 and total lime requirements. Without molybdenum the yields were 17, 17, 19 and 19 bushels for the various rates of lime. The increases for molybdenum (4-year average) were 5, 4, 2 and 2 bushels, respectively, for each rate of lime (significant at .05% level). The response to molybdenum for the higher rates (900, 1800 and 2700 pounds per acre) was small for the last two years (1965-66) but greater than the molybdenum response for the years 1963-64.

Here again this may indicate a deficiency of available soil molybdenum. with the higher lime rates, because of plant uptake.

Lime without molybdenum (4-year average) produced yields as follows: 17, 17, 19 and 19 bushels per acre for the 500, 900, 1800 and 2700 pounds per acre rate, an increase of 2, 2, 4 and 4 bushels, respectively, for the various lime rates (significant at .05% level). The no lime treatment yielded 15 bushels per acre.

It is interesting to note that the response of soybeans to molybdenum decreased as the lime rates increased and the response to applied lime increased as the lime rates increased and the increases were essentially the same. Soil test showed the pH value of this soil increases as the rates of lime increased. The pH values (1963) were as follows: 5.4, 5.5, 5.9, 6.1 and 6.4 for the various rates of lime, and (in 1966) 5.2, 5.4, 5.4, 5.6 and 5.7. This decrease in soil

Table 14. The effect of Mo and Lime on the production of soybeans; Brown Loam Branch Station, Raymond, Mississippi.

Soil Type: Grenada Silt Loam: P₂O₅H = 183 lbs., KL+ = 164 lbs.

Lime rate	pH value				Treat-ment	Yield bu. per acre				
	1963	1964	1965	1966		1963	1964	1965	1966	4-yr. ave.
No Lime	4.7	4.7	4.9	4.8	Mo	30	45	35	37	37
Same	4.7	4.7	4.9	4.8	No Mo	25	37	29	29	30
1000 lbs. drilled L.	5.0	4.9	5.3	4.9	Mo	30	44	40	43	39
Same	5.0	4.9	5.3	4.9	No Mo	24	41	34	39	35
2000 lbs. (BC) L.	5.3	5.1	5.3	5.0	Mo	29	47	40	39	39
Same	5.3	5.1	5.3	5.0	No Mo	26	43	32	30	33
4000 lbs. (BC) L.	5.5	5.4	5.4	5.1	Mo	30	48	43	42	41
Same	5.5	5.4	5.4	5.1	No Mo	28	44	39	37	37
6000 lbs. (BC) L.	6.0	6.2	5.7	5.3	Mo	33	45	42	44	41
Same	6.0	6.2	5.7	5.3	No Mo	33	45	42	44	41
LSD .05						2 bu.	5 bu.	4 bu.	4 bu.	4 bu.
.01						3 bu.	6 bu.	5 bu.	5 bu.	5 bu.
CV						5.2%	9.4%	8.2%	8.2%	

Mo = Molybdenum.

Drilled L. = Lime (Dolomite) drilled at seeding time.

(BC) = Broadcast lime (Dolomite).

Table 15. Weekly rainfall data for the 4-year period 1963-66 for the month of June, July, August, and September; Brown Loam Branch Station, Raymond, Mississippi.

	Inches of rainfall per week			
	1963	1964	1965	1966
JUNE				
1-7	.00	.02	1.02	.00
8-14	.00	1.87	2.64	.00
15-21	.81	.40	.42	.22
22-28	1.14	.94	1.83	.00
29-30	.46	.10	.00	.00
Total	2.86	3.33	5.91	.22
JULY				
1-7	2.55	.75	.00	1.66
8-14	1.34	2.74	.58	.26
15-21	.00	1.73	.00	.99
22-28	2.86	2.14	2.50	.03
29-31	1.19	.99	.27	.26
Total	7.58	8.35	3.35	3.20
AUGUST				
1-7	.00	1.21	.00	1.01
8-14	.23	.00	3.12	.48
15-21	1.77	1.79	.04	.58
22-28	.00	1.57	.66	.00
29-31	.54	.00	.22	.84
Total	2.54	4.57	4.04	2.91
SEPTEMBER				
1-7	.00	.13	.04	3.14
8-14	.00	.00	2.26	.18
15-21	.00	.12	.05	2.17
22-28	.09	1.32	1.23	.09
29-31	.00	1.69	.04	.00
Total	.09	3.26	3.62	5.58
Total 4 months	13.07	19.51	16.92	11.91

pH might have been expected after 4 years of cropping.

The 4-year average rainfall for July was 4.38 inches and for August 3.47 inches (Table 4). Rainfall for the 4 months, June, July, August and September for the years 1964, 1965 and 1966 totaled 13, 11 and 11 inches, respectively. This was considerably less than amounts required (15 to 20 inches) for optimum soybean production. This low rainfall no doubt, reduced yields during this period.

Molybdenum And Lime Experiment On Bude Very Fine Sandy Loam

This molybdenum and lime rates test was conducted for 4 years on Bude very fine sandy loam (Flatwoods Soil) at the Pontotoc Ridge-Flatwoods Branch Station, Pontotoc, Mississippi. Surface soil samples collected before the experiment was initiated had a pH value of 5.7. The available P_2O_5 and K was 93 and 95 pounds per acre, respectively. Dolomitic limestone was added in the amount of 3600 pounds per acre, (total lime requirement) the amount required to raise the soil pH value to 6.5. At seeding time 1/6 (600 lbs. an acre) of the total lime requirement was drilled annually. During the year 1963 (only) the 1/3 (1200 lbs. an acre) the 2/3 (2400 lbs. an acre) were broadcast and mixed with the soil. Annual applications of 0-80-80 was drilled at the time of seeding.

Yields with and without molybdenum and pH value are shown in Table 17.

The 4-year average yields were 23 bushels of soybeans per acre for the no lime- no molybdenum treatments and 28 bushels for the molybdenum no lime treatment, an increase of 5 bushels per acre for the molybdenum (significant at .05% level). Molybdenum and lime treatments produced 32, 30, 33 and 34 bushels, respectively, for the 1/6, 1/3, 2/3 and total lime requirement. Without molybdenum the yields were 29, 29, 31 and 31 bushels an acre, an increase due to molybdenum of 3, 1, 2 and 3 bushels for each rate of lime (significant at .05% level).

There was very little difference in response of soybeans to molybdenum and lime during the first two years (1963-64) as compared with the last two years (1965-66) for the higher rates of lime. Lime without molybdenum (4-year average) produced yields as follows: 29, 29, 31 and 31, respectively, for the 600 1200, 2400 and 3600 per acre rate, increases of 6, 6, 8 and 8 bushels (significant at .01% level). The no lime no molybdenum treatment yielded 23 bushels per acre. On this soil, lime increased soybean yields even more than molybdenum without lime.

Soil tests in 1963 showed the pH value of this soil increases as the rates of lime increased. The pH value in 1963 after lime had been applied were: 5.7, 5.9, 6.2, 6.7 and 6.7, and in 1966 5.3, 5.5, 5.7, 6.0 and 6.1, respectively for the various rates of lime. This increase (in 1963) as well as the decrease pH

Table 16. The effect of Mo and Lime on the production of soybeans; Pontotoc Ridge Flatwoods Branch Station, Pontotoc, Mississippi.

Soil Type: Atwood Silty Clay Loam: P_2O_5 L 45 lbs., KM— 294 lbs.

Lime rate	pH value				Treatment	Yield bu. per acre				
	1963	1964	1965	1966		1963	1964	1965	1966	4-yr. ave.
No lime	5.4	5.4	5.6	5.2	Mo	31	17	16	20	21
Same	5.4	5.4	5.6	5.2	No Mo	22	12	12	15	15
500 lbs. drilled L.	5.5	5.7	5.6	5.4	Mo	31	16	18	22	22
Same	5.5	5.7	5.6	5.4	No Mo	24	12	14	18	17
900 lbs. (BC) L.	5.9	5.7	5.7	5.4	Mo	31	16	17	21	21
Same	5.9	5.7	5.7	5.4	No Mo	26	14	12	17	17
1800 lbs. (BC) L.	6.1	6.4	6.0	5.6	Mo	32	15	17	20	21
Same	6.1	6.4	6.0	5.6	No Mo	31	12	14	17	19
2700 lbs. (BC) L.	6.4	6.1	6.2	5.7	Mo	33	14	17	21	21
Same	6.4	6.1	6.2	5.7	No Mo	31	14	14	18	19
LSD to test Mo means	.05					4 bu.	2 bu.	2 bu.	2 bu.	2 bu.
	.01					NS	3 bu.	3 bu.	3 bu.	3 bu.
CV						11.7%	8.8%	10.1%	8.9%	

Mo = Molybdenum.

Drilled L. = Lime (Dolomite) drilled at seeding time.

(BC) = Broadcast Lime (Dolomite) (lime req. 2700 lbs. per acre) pH 6.5

(in 1966) for the various rates of lime was about as expected. Increased rates of lime usually raise the soil pH levels in proportion to the amounts of lime applied, and after 4 years cropping pH values are usually reduced below the original pH and in proportion to amounts of lime applied. (See Table 4 for rainfall data.)

Molybdenum And Lime Experiment On Tilden Fine Sandy Loam

This molybdenum and lime rates test was conducted for 4-years on Tilden fine sandy loam (Coastal Plain Soil) at the Northeast Mississippi Branch Station, Verona, Mississippi.

Surface soil samples collected before the experiment began had a pH value of 4.8. The available P_2O_5 and K was 30 pounds and 150 pounds per acre, respectively.

The total lime requirement for this soil was 4000 pounds per acre, the amount needed for a pH 6.5. At planting time 1/6 (650 pounds an acre) of the total lime requirement was drilled annually. During 1963 (only) the 1/3 (1300 pounds per acre) the 2/3 (2600 pounds per acre) and the total lime requirement (4000 pounds per acre) were broadcast and mixed with the soil.

Yields with and without molybdenum and the pH values are shown in Table 18. The 4-year average yields were 20 bushels of soybeans an acre for the no lime-no molybdenum treatment and 25 bushels for the no lime-molybdenum

treatment, an increase of 5 bushels for molybdenum (significant at .01% level). The molybdenum and lime treatments produced 26, 25, 24 and 25 bushels, respectively, for the 1/6, 1/3, 2/3 and total lime requirements. Without molybdenum the yields were 21, 21, 23 and 23 bushels an acre, an increase for molybdenum of 5, 4, 1 and 2 bushels for each lime rate (significant at .01% level, for the two lower rates, but not significant for the higher rates).

Lime without molybdenum (4 year average) yields were 21, 21, 23 and 23 bushels per acre, respectively, for the 650, 1300, 2600 and 4000 pound rates, in increase due to lime alone of 1, 1, 3 and 3 bushels per acre (significant at .05% level for higher rate). The no lime-molybdenum treatment yielded 20 bushels per acre (4 year average). Evidently there was not enough lime applied at the two lower rates to satisfy the needs of the soybean plant for optimum production, since only very small responses were obtained. The two higher rates of lime increased yields 3 bushels per acre, which was 2 bushels less than molybdenum alone.

The responses of soybeans to molybdenum with the various rates of lime for the first 2 years (1963-1964) was small, increases of only 3, 2, 0 and 0 bushels per acre as compared with increases for the last years (1965-66) of 7, 6, 1 and 2 bushels per acre, respectively. This may indicate that the soybean plants have used all of the

Table 17. The effect of Mo and Lime on the production of soybeans; Pontotoc Ridge-Flatwoods Branch Station, Pontotoc, Mississippi.

Soil Type: Bude Very Fine Sandy Loam: P_2O_5 L + 93 lbs., KL— 95 lbs.

Lime rate	pH value				Treat-ment	Yield bu. per acre				4-yr. ave.
	1963	1964	1965	1966		1963	1964	1965	1966	
No lime	5.7	5.4	5.5	5.3	Mo	37	23	27	25	28
Same	5.7	5.4	5.5	5.3	No Mo	36	17	20	17	23
600 lbs. drilled L.	5.9	5.5	5.9	5.5	Mo	41	24	31	33	32
Same	5.9	5.5	5.9	5.5	No Mo	38	21	27	28	29
1200 lbs. (BC) L.	6.2	5.7	5.9	5.7	Mo	40	24	28	29	30
Same	6.2	5.7	5.9	5.7	No Mo	42	22	25	26	29
2400 lbs. (BC) L.	6.7	6.1	6.1	6.0	Mo	45	24	30	33	33
Same	6.7	6.1	6.1	6.0	No Mo	42	24	29	29	31
3600 lbs. (BC) L.	6.7	6.0	6.6	6.1	Mo	45	25	32	32	34
Same	6.7	6.0	6.6	6.1	No Mo	40	24	29	30	31
LSD .05						NS	2 bu.	4 bu.	2 bu.	3 bu.
.01						NS	3 bu.	5 bu.	3 bu.	4 bu.
CV						10.6%	8.5%	11.5%	6.8%	

Mo = Molybdenum.

Drilled L. = Lime (Dolomite) drilled at seeding time.

(BC) = Broadcast (Dolomite) lime. Total req. 3600 lbs. per acre.

soil molybdenum available by the small rates of lime and there is evidence of the need of added molybdenum even where higher lime rates were employed.

Soil test showed the pH value of the soil increased as the rates of lime increased. There was also a decrease in pH values for each year during the 4-year period.

The 4-year average rainfall for July was 6.78 inches and for August 2.91 inches (Table 6). Rainfall for July over the 4-year period was not very well distributed, although it was above average, while the August rainfall was below average. Excessive moisture in July 1964 and limited moisture in 1965 and 1966 for the 4 months of June, July, August and September was principally responsible for the reduced yields of soybeans during the last three years of the experiment.

Molybdenum And Lime Experiments On Prentiss Fine Sandy Loam

This molybdenum and lime rates test was conducted for 4-years on Prentiss fine sandy loam (Coastal Plain Soil) at the Coastal Plain Branch Station, Newton, Mississippi.

Surface soil samples collected before the experiment began had a pH value of 4.8. The available P_2O_5 and K was 161 and 151 pounds per acre, respectively.

The total lime requirement for this soil was 4000 pounds per acre, the amount needed for a pH value 6.5. At

seeding time 1/6 (650 pounds an acre) of the total lime requirement was drilled annually. During the year 1963 (only) the 1/3 (1300 pounds an acre) the 2/3 (2600 pounds per acre) and the total lime requirement (4000 pounds an acre) were broadcast and mixed with the soil.

Yields with and without molybdenum and the pH values are shown in Table 19. The 4-year average yields were 28 bushels of beans per acre for the no lime-no molybdenum treatment and 36 bushels for the no lime-molybdenum treatment, an increase of 8 bushels for molybdenum (significant at .01% level). The molybdenum and lime treatments produced 38, 35, 35 and 36 bushels per acre, respectively, for the 1/6, 1/3, 2/3 and total lime requirement. Without molybdenum the yields were 33, 30, 32 and 34 bushels, an increase for molybdenum of 5, 5, 3 and 2 bushels per acre, respectively, for each lime rate (significant at .01% level for two low rates, also significant at .05% level for the 2600 lb. rate, not significant for the higher rate).

Lime without molybdenum (4-year average) yields were 33, 30, 32 and 34 bushels per acre, respectively, for the various rates of lime, an increase of 5, 2, 4 and 6 bushels for lime without molybdenum (significant at .01% level). It is interesting to note that lime without molybdenum increased soybean yields for each rate of lime and the data is somewhat inconsistent. How-

Table 18. The effect of Mo and Lime on the production of soybeans; Northeast Mississippi Branch Station, Verona, Mississippi.

Soil Type: Tilden Fine Sandy Loam: P_2O_5 — 30 lbs., K 150 lbs.

Lime rate	pH value				Treat- ment	Yield bu. per acre				
	1963	1964	1965	1966		1963	1964	1965	1966	4-yr. ave.
No lime	4.8	4.9	4.9	4.9	Mo	32	17	28	24	25
Same	4.8	4.9	4.9	4.9	No Mo	28	14	20	16	20
650 lbs. drilled L.	5.0	5.0	5.5	4.9	Mo	34	16	29	26	26
Same	5.0	5.0	5.5	4.9	No Mo	30	13	20	21	21
1300 lbs. (BC) L.	5.1	5.0	5.5	5.2	Mo	34	17	27	23	25
Same	5.1	5.0	5.5	5.2	No Mo	31	16	19	18	21
2600 lbs. (BC) L.	5.7	5.4	5.6	5.2	Mo	32	14	26	24	24
Same	5.7	5.4	5.6	5.2	No Mo	32	14	26	21	23
4000 lbs. (BC) L.	6.0	5.5	6.1	5.4	Mo	32	13	27	26	25
Same	6.0	5.5	6.1	5.4	No Mo	32	12	26	23	23
LSD .05						2 bu.	3 bu.	5 bu.	2 bu.	3 bu.
.01						3 bu.	4 bu.	6 bu.	3 bu.	4 bu.
CV						5.0%	18.9%	16.0%	7.4%	

Mo = Molybdenum.

Drilled L. = Lime (Dolomite) drilled at seeding time.

(BC) = Broadcast lime (Dolomite).

ever, in no case did lime increase yields equal to molybdenum without lime.

The response of soybeans to molybdenum with the various rates of lime for the first two years (1963-1964) were small increases of only 4, 4, 2 and 0 bushels per acre as compared with the last two years (1965-1966) of 6, 5, 5 and 3 bushels per acre, respectively. This larger increase in soybean yields for the last two years (1965-1966) for molybdenum with the various lime rates could very well be due to cropping out the soil molybdenum made available by the lime. According to soil test data the pH value for the most part increased as the rates of lime increased for each year of the experiment (1963-1966). There was also somewhat of a gradual decrease in pH value following each crop year, this is particular true for the higher lime rates.

Average rainfall for July was 4.40 inches and for August 5.10 inches (Table 20). The rainfall was fairly well distributed throughout the growing season. The amount was apparently nearly adequate for good soybean production, and no doubt was partially responsible for the better than average soybean yields.

Molybdenum And Lime Experiment On Brooksville Clay

This molybdenum and lime test was conducted for the 4-year period (1963-1966) on Brooksville Clay (Black Land Soils) at the Black Belt Branch Experi-

ment Station, Brooksville, Mississippi. Surface soil samples collected before the experiment was initiated had a pH of 6.2. The available P_2O_5 and K was 30 pounds and 100 pounds an acre, respectively. Dolomitic limestone was added (drilled) on each limed plot (8 rows) at the rates of 500 pounds per acre annually. The remaining 8 rows of each plot received no lime.

Annual applications of 0-80-80 was drilled at time of seeding in 1963, 1964 and 1965. In 1966 the fertilizer 0-80-80 was drilled in the fall, and beds made ready for spring seeding.

Yields with and without molybdenum on limed and unlimed soils and the pH values are shown in Table 21. The 4-year average yield was 37 bushels per acre for the no lime-no molybdenum treatment (pH 6.2) and 39 bushels for the molybdenum no lime treatment, an increase of 2 bushels for the molybdenum treatment (significant at .05% level). The molybdenum and lime treatments produced 39 bushels an acre, and the lime-no molybdenum treatments yielded 37 bushels, an increase of 3 bushels for molybdenum. As one might expect there was no yield increase due to lime (pH 6.2) and only small increases for molybdenum.

The change in pH value due to liming of this soil was somewhat inconsistent, however, in 1964 and 1965 there was an increase in pH for the lime treatment. For some unknown reason the

Table 19. The effect of Mo and Lime on the production of soybeans; Coastal Plain Branch Station, Newton, Mississippi.

Soil Type: Prentiss Fine Sandy Loam: P_2O_5 161 lbs. - K 151 lbs.

Lime rate	pH value				Treat- ment	Yield bu. per acre				4-yr. ave.
	1963	1964	1965	1966		1963	1964	1965	1966	
No lime	4.8	5.0	4.9	5.0	Mo	30	34	46	32	36
Same	4.8	5.0	4.9	5.0	No Mo	25	28	37	21	28
650 lbs. drilled L.	5.2	5.2	5.4	5.3	Mo	30	36	50	35	38
Same	5.2	5.2	5.4	5.3	No Mo	29	29	43	31	33
1300 lbs. (BC) L.	5.6	5.5	5.4	5.2	Mo	30	29	48	31	35
Same	5.6	5.5	5.4	5.2	No Mo	26	26	43	26	30
2600 lbs. (BC) L.	6.1	5.8	5.5	5.3	Mo	28	31	49	32	35
Same	6.1	5.8	5.5	5.3	No Mo	27	29	43	29	32
4000 lbs. (BC) L.	6.3	5.8	5.9	5.7	Mo	30	33	48	32	36
Same	6.3	5.8	5.9	5.7	No Mo	30	33	43	30	34
LSD .05						2 bu.	3 bu.	5 bu.	3 bu.	3 bu.
.01						2 bu.	4 bu.	7 bu.	4 bu.	4 bu.
CV						10.7%	8.0%	9.5%	9.2%	

Mo = Molybdenum.

Drilled L. = Lime (Dolomite) drilled at seeding time.

(BC) = Broadcast lime (Dolomite).

pH values for the lime and no lime treatments were essentially the same for the year 1966. I doubt if this change in pH value on the no lime plots was due to soil mixing from the lime plots.

The lime was drilled each year, and buffer rows used between limed and

unlimed areas. These soils are usually well supplied with lime, and with perhaps enough available molybdenum for good soybean production for the time being anyway.

See rainfall data and discussion Table 8; (Rates of P_2O_5 and K_2O experiments).

Table 20. 1966 weekly rainfall data for the 4-year period 1963-66 for months of June, July, August and September; Coastal Plain Branch Station, Newton, Mississippi.

	Inches of rainfall per week			
	1963	1964	1965	1966
JUNE				
1-7	.00	.00	.44	.12
8-14	.11	.40	1.03	1.33
15-21	4.38	.22	.57	.21
22-28	1.14	3.40	.03	.36
29-30	.00	1.33	.00	.00
Total	5.63	5.35	2.07	2.02
JULY				
1-7	.45	.37	1.81	.11
8-14	1.44	1.74	.73	.18
15-21	1.90	5.00	2.25	1.13
22-28	.38	2.71	.49	.00
29-30	.30	.23	.38	1.03
Total	4.47	5.05	5.66	2.45
AUGUST				
1-7	.28	.15	.37	1.10
8-14	2.58	.69	5.30	1.47
15-21	.05	1.08	1.61	.86
22-28	1.92	1.95	.37	.01
29-30	.02	.00	.00	.61
Total	4.85	3.87	7.65	4.05
SEPTEMBER				
1-7	.26	.00	1.57	.14
8-14	.21	.00	1.35	.05
15-21	.02	2.09	.38	2.72
22-28	.05	.00	.50	2.40
29-30	.00	2.01	1.05	.00
Total	.54	4.10	4.85	5.31
Total 4 months	15.49	18.37	20.23	13.85

Table 21. The effect of Mo and Lime on the production of soybeans; Black Belt Branch Station, Brooksville, Mississippi.

Soil Type: Brooksville Clay: P_2O_5 75 lbs. - K 175 lbs.

Lime rate	pH value				Treat-ment	Yield bu. per acre				4-yr. ave.
	1963	1964	1965	1966		1963	1964	1965	1966	
No lime	6.2	6.2	5.9	6.3	Mo	34	40	38	43	39
Same	6.2	6.2	5.9	6.2	No Mo	34	35	36	41	37
500 lbs. drilled L.	6.2	6.5	6.2	6.3	Mo	35	41	36	42	39
Same	6.2	6.5	6.2	6.3	No Mo	34	37	32	40	36
LSD .05	NS					2 bu.	3 bu.	2 bu.	2 bu.	
.01						3 bu.	4 bu.	3 bu.	3 bu.	
CV						5.0%	6.9%	5.7%		

Mo = Molybdenum.

Drilled L. = Lime (Dolomite) drilled at seeding time 1963-1964 and 1965.

No broadcast lime applies since soil pH is about 6.0.

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APPENDIX

Appendix Table 1. Rates of phosphorus experiment.

Treatments	Soybean yields bushels per acre (5-year average)			
	NM	PR-FW	NEM	BB
0-0-0	24	29	24	9
0-0-40	26	30	28	10
0-20-40	30	30	32	21
0-40-40	31	30	34	25
0-80-40	34	30	34	32
0-40-40 + Mg.	—	—	—	27
Levels of and available				
K ₂ O pounds per acre, 1963	L—, 17	L+, 88	L, 52	L—, 4

Appendix Table 2. Rates of potassium experiment.

Treatments	Soybean yields bushels per acre (5-year average)			
	NM	PR-FW	NEM	BB
0-40-0	28	26	25	28
0-40-20	31	27	28	30
0-40-40	32	28	30	30
0-40-80	33	27	32	29
0-40-40 + FTE	33	27	31	30
Levels of and available				
K pounds per acre, 1963	L, 129	L+ 227	L—, 68	L, 180

Appendix Table 3. Rates of phosphorus experiment.

Black Belt Branch Experiment Station.

Treatment	Soybean yields bushels per acre, 1966
0-0-40	33
0-20-40	37
0-40-40	39
0-80-40	41
Levels of and available	
P ₂ O ₅ pounds per acre, 1966	L—, 20

NM—North Mississippi Branch Station, Holly Springs.

PR-FW—Pontotoc Ridge-Flatwoods Branch Station, Pontotoc.

NEM—Northeast Mississippi Branch Station, Verona.

BB—Black Belt Branch Station, Brooksville.

Appendix Table 4. Rates of phosphorus experiment.

Soil Type: Brooksville Clay; pH 6.6

Black Belt Branch Experiment Station, Brooksville, Miss.

13-13-13 source of phosphorus

Rates of P ₂ O ₅ per acre	Soybean yields bushels per acre (2-year average) 1964-1965	
	Applied fertilizer	Residual fertilizer
0	13	13
15	25	16
30	28	16
45	35	24
60	36	24
Levels of and available		
P ₂ O ₅ pounds per acre, 1964	3L—	2L—

Appendix Table 5. Rainfall data.

Months	Inches rainfall (4-year average)			
	NM	PR-FW	NEM	BB
June	2.05	1.98	3.85	3.26
July	3.58	4.38	6.78	5.13
August	3.82	3.47	2.91	4.72
September	4.01	2.95	3.22	3.06
Total	13.46	12.77	16.76	16.17

Appendix Table 6. Molybdenum and lime experiment.

Brown loam soil

Soil Type: Grenada silt loam

Lime rates for various pH levels	North Mississippi Branch Station			Brown Loam Branch Station		
	pH value	Bu./acre, 4-yr. ave.		pH value	Bu./acre, 4-yr. ave.	
		Mo	No Mo		Mo	No Mo
0	4.80	35	27	4.80	37	30
1/6	5.15	37	32	5.02	39	35
1/3	5.35	36	30	5.42	39	33
2/3	5.52	36	34	5.40	41	37
Total	5.87	36	35	5.80	41	41

6000 pounds, total lime requirement pH 6.5.

Levels of and available P₂O₅ and K poundsper acre: P₂O₅: H, 165

K: L+, 186

Levels of and available P₂O₅ and K pounds per acre:P₂O₅: H, 183

K: L+, 164

Appendix Table 7. Molybdenum and lime experiments.

Coastal Plain Soils

Lime rates for various pH levels	Soil type: Atwood SCL Pontotoc Ridge Branch Experiment Station			Soil type: Tilden FSL Northeast Miss. Branch Experiment Station			Soil type: Prentiss FSL Coastal Plain Branch Experiment Station		
	pH value	Bu. per acre 4-yr. average		pH value	Bu. per acre 4-yr. average		pH value	Bu. per acre 4-yr. average	
		Mo	No Mo		Mo	No Mo		Mo	No Mo
0	5.40	21	15	4.87	25	20	4.92	36	28
1/6	5.55	22	17	5.10	26	21	5.25	38	33
1/3	5.69	21	17	5.20	25	21	5.42	35	30
2/3	6.02	21	19	5.47	24	23	5.67	35	32
Total	6.10	21	19	5.75	25	23	5.92	36	34

2700 pounds total lime requirements pH 6.5.

Levels of and available P₂O₅ and K per acre.P₂O₅: L—, 45 lbs.

K: M—, 294 lbs.

P₂O₅: L+, 30 lbs.

K: L—, 150 lbs.

4000 pounds total lime requirements pH 6.5.

P₂O₅: M, 161 lbs.

K: L—, 151 lbs.

Appendix Table 8. Molybdenum and lime experiment.

Lime rates for various pH levels	Flatwoods soil Soil type: Bude very fine, SL Pontotoc Ridge Branch Experiment Station			Black land soil Soil type: Brooksville clay Black Belt Branch Experiment Station		
	pH value	Bu./acre, 4-yr. ave.		pH value	Bu./acre, 4-yr. ave.	
		Mo	No Mo		Mo	No Mo
0	5.47	28	23	6.15	39	37
1/6	5.70	32	29	6.30	39	36
1/3	5.87	30	29			
2/3	6.22	33	31			
Total	6.35	34	31			

3600 pounds total lime requirement pH 6.5.

Levels of and available P₂O₅ and K per acre.P₂O₅: L+, 93 lbs.

K: L—, 95 lbs

500 lime drilled annually.

P₂O₅: L, 75 lbs.

K: L, 175 lbs.

Appendix Table 9. Rainfall data.

Months	Inches rainfall (4-year average)	
	Coastal Plain Station	Brown Loam Station
June	3.76	3.08
July	4.40	5.62
August	5.10	3.51
September	3.70	3.13
Total	16.96	15.34



The Relation of Sieve Size, Pod Weight and Harvest Period of Snap Bean Varieties for Processing



**Mississippi State University
AGRICULTURAL EXPERIMENT STATION**

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The Relation of Sieve Size, Pod Weight, and Harvest Period of Snap Bean Varieties for Processing

By E. L. MOORE and W. W. WATSON¹

Snap bean production in the Mississippi Delta developed suddenly into a rather large operation in 1966. The plantation owners were well informed and equipped for cotton and soybean production but were not accustomed to the production of a perishable vegetable crop.

Test plots were set up at Stoneville and State College in order to obtain research data and answer future questions which would undoubtedly arise in the mechanized production of snap beans in the Delta. The tests were conducted jointly by the Delta Branch Station and the Department of Horticulture.

The plots consisted of four rows of each of several varieties. Cultural practices throughout the season were designed to duplicate a commercial mechanized operation. Sample data were obtained at random from each plot of the several plantings. The spring planting was made April 20 and the fall planting August 18. The varieties used, harvest dates and results obtained are presented in the accompanying tables. The data are from one year of study and this is a progress report.

Snap beans, like most vegetables, must be harvested at the proper time to get a top quality product. Processors recognize this fact and specify in their contract with growers that only pods of certain sieve sizes will be acceptable. The requirements vary among processors but in general they prefer that 20 to 40 percent of the pods in a load be sieve 5 and others sieve 3 and 4. The preference of a processor is specified to his contract growers.

Sieve size is based on pod diameter.

Sizes 3, 4 and 5 are generally accepted and range in diameter from 18.5/64 to 27/64 of an inch inclusive. The premium prices goes from the smaller sizes which weigh considerably less than the large pods as shown in Table 1.

Sieve size alone does not insure good quality. Many factors such as variety, cultural practices, moisture and temperature govern quality. Pods with high fiber content are of poor quality and not acceptable for processing. The proper varieties grown under good conditions usually retain excellent processing qualities until the pods have developed well into sieve 5. Then a rapid rate of seed and fiber development start and the quality of the product is reduced. The rate of seed and fiber development varies among varieties, and is affected by temperature. The rate increases at higher temperatures.

The relationship of sieve size, weight and dollar value in 1966 is presented in Table 1. These data show a relative increase in weight of 1.4 as the pods grew from one sieve size to the next. They also show the relative dollar value. A serious study of the data indicates that delaying harvest to increase tonnage per acre may not be profitable.

It should be noted that harvesting and hauling costs are generally on a ton basis. Increasing the tonnage at the sake of quality usually reduces the net income. The data obtained for this table were based on average measurements of three, 2-pound samples from each of four varieties. The pods in a sample were counted, weighed and these values were converted by proportion to weights per 100 pods. The average weight of 100 pods within a sieve size varied among varieties but the relative weight of one sieve size to another was very similar for all varieties tested. Therefore, the data from all varieties were pooled.

¹E. L. Moore, Horticulturist, Department of Horticulture, State College, Mississippi. W. W. Watson, formerly Assistant Superintendent, Delta Branch Station, Stoneville, Mississippi. The authors acknowledge with gratitude the assistance of Dr. G. M. Campbell during the final stages of the field work on these studies.

Table 1. The relation of sieve size, weight and dollar value of snap beans.

Sieve size	Pod diameter in 64ths inch	Weight of 100 pods (grms.)	Relative weight (tons)	Price per ton	Ton value (dollars)
3	18.5 to 21	452	1.0	110	110
4	21 to 24	638	1.4	80	112
5	24 to 27	829	1.8	50	90

Table 2. Average number of days required for pods of several snap bean varieties to pass from one sieve size to another during the month of July 1966.¹

Variety	Sieve sizes					
	1-2	2-3	3-4	4-5	5-6	6-7
Corneli 14	1.5	1.3	1.4	1.5	2.9	5.7
Harvester	1.2	1.1	1.5	2.1	3.6	5.9
Slenderwhite	1.1	1.3	1.5	1.5	3.0	5.4
Provider	1.7	1.2	2.0	1.7	3.7	6.6
Extender	1.4	1.3	1.2	1.5	2.7	5.4
Bush Blue Lake 274	1.3	1.2	1.8	1.4	3.2	5.7
Cascade	1.4	1.2	1.5	1.3	2.8	5.4

¹The maximum temperatures ranged from 93 to 98 with an average of 96° F. and the minimum temperatures ranged from 68 to 78 with an average 73° F.

The average time in days required for pods of several bean varieties in the spring planting to grow from one sieve size to another during the early part of July is presented in Table 2. The average of the maximum temperatures during the pod growing period was 96° F. The average minimum was 73. To obtain these data, 10 pods in each of 10 different locations in each variety were identified by tags and measured daily. Each value represents the average of 100 pods.

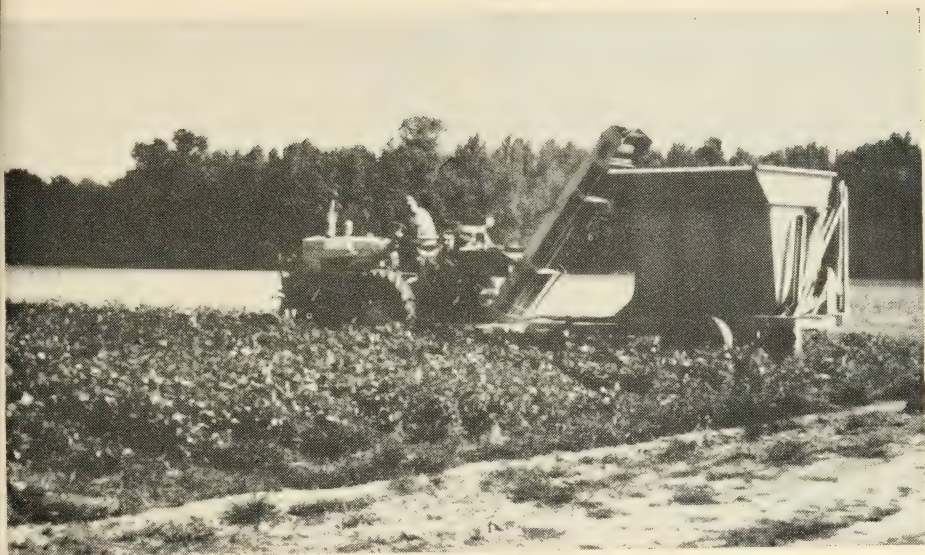
Differences existed among varieties in the time required to grow from one sieve size to another. It would be necessary to study the variety being grown for perfect scheduling of harvest operation. In general, 1.2 to 1.5 days were required. A most significant point of these data is shown under Sieve Size Column 3-5. Only three days were required for the pods to pass from sieve 3 to 5 inclusive. This shows that the maximum harvest period of a given planting was three days.

The data indicated that the acreage of beans planted on any one date should be governed by the acreage that can be harvested in one day with the harvesting equipment available. The data further indicates that harvesting operations should

be done within one day after about 40 percent of the pods have reached sieve 4. This type of scheduling should give the grower the maximum tonnage and price. It should provide the processor with a top quality product. Earlier harvesting would reduce potential yield. Later harvesting would increase yield, reduce the price per ton and lower the quality of the product. Too much delay would render the crop unacceptable.

Similar data on pod growth for the fall crop are presented in Table 3. The average maximum temperature was 80° F., and the average minimum was 61° F. during the pod growing period. Although there were inconsistencies in the data with certain varieties (Corneli 14, Harvester, and Provider), most varieties required from one-half to a full day longer for the pods to develop in September than in July.

Presented in Table 4 are data on the yield in tons per acre, sieve size, and calculated value of several bean varieties in the spring planting. It is emphasized that comparisons of the yields between varieties can be misleading. The varieties were not harvested at comparable stages of maturity. The varieties Extender, Provider and Harvester are excellent fresh



Picking snap beans mechanically in the Mississippi Delta.

Table 3. Average number of days required for pods of several snap bean varieties to pass from one sieve size to another in September 1966.¹

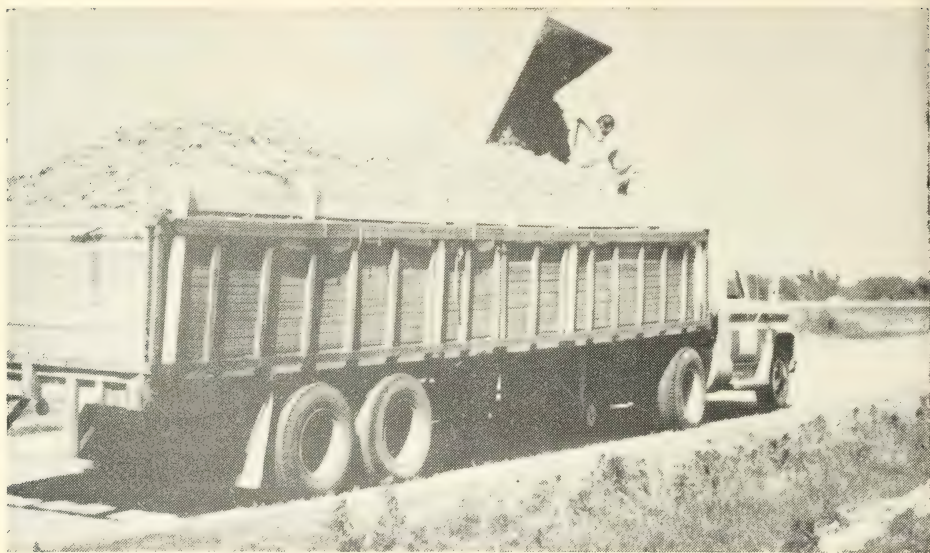
Variety	Sieve sizes					
	1-2	2-3	3-4	4-5	5-6	6-7
Corneli 14	1.1	1.7	1.1	1.2	2.3	5.1
Harvester	1.2	1.4	1.3	1.8	2.1	5.7
Slenderwhite	1.3	1.3	1.6	2.2	3.8	6.4
Provider	2.0	1.7	1.0	1.8	2.8	6.5
Extender	1.5	1.9	1.1	1.2	2.3	5.7
Bush Blue Lake 274	1.7	2.0	1.3	1.3	2.6	6.3
Cascade	2.0	1.7	1.0	1.8	2.8	6.5
White Seeded Tendercrop	1.7	1.7	1.3	2.5	3.8	7.0

¹The maximum temperatures ranged from 87 to 69 with an average of 80° F., and the minimum temperatures from 55 to 67 with an average of 61° F.

Table 4. The relation of harvest date to yield, sieve size, and dollar value of several snap bean varieties.

Variety	Harvested June 10, 1966			Harvested June 15, 1966		
	Yield (tpa)	Sieve size (percent)	Value ¹ (dollars)	Yield (tpa)	Sieve size (percent)	Value ¹ (dollars)
		5 - 4 - 3			5 - 4	
Corneli 14	1.9	0-45-45	160	3.2	75-25	160
Harvester	1.6	15-30-55	135	2.8	60-40	192
Slenderwhite	2.3	0-66-33	205	3.4	70-30	201
Provider	3.0	65-25-10	190	2.8	85-15	153
Extender	2.5	80-15-5	144	2.6	95-5	134
Bush Blue Lake 274	1.6	0-25-40	112	3.8	85-15	207
Cascade	1.8	0-35-40	130	3.9	60-40	242

¹The dollar value was based on a price per ton of \$50 for sieve size 5, \$80 for 4 and \$110 for 3.



Mechanical picker dumps beans into truck for movement to processing plant.

market beans. Their yields were high in this test as has been noted in other tests of fresh market varieties in the state. The pods of Provider and Extender had passed the desirable time of harvest in this test. This favored high yield and low value as compared to the other varieties. Seed and fiber development occurs early in Harvester, Provider and Extender and they are not generally well suited for processing beans.

The other varieties were harvested either too early (June 10) or too late (June 15) for best sieve size-tonnage relationship. These data emphasize the importance of harvesting at the proper sieve size. The data on the variety Cascade offer a good example. On June 10 the yield was 1.8 tons per acre. The 5-4-3 sieve percentages were 0-35-40. This very definitely was too early for ideal harvest and was reflected in the low yield. On June 15 the yield was 3.9 tons per acre and the 5-4 sieve percentages of 60-40 was heavy toward large pods but considered acceptable.

The data of the varieties Slenderwhite, Bush Blue Lake 274 and Corneli 14 are similar to Cascade. It appeared that the

rate of seed and fiber development was slowest in Cascade and followed closely by Slenderwhite. The varieties Slenderwhite, Bush Blue Lake 274, Cascade and Corneli 14 each have acceptable concentration of pod set and are considered suitable for mechanical harvest and processing.

The relationship of harvest date to yield, sieve size and calculated value of several varieties of the fall planting are shown in Table 5. There were three harvest dates at three day intervals with each variety being harvested twice.

As stated relative to Table 4, strict yield comparisons should be avoided, because of variations in stages of pod development among the varieties on any one harvest date. Relatively valid comparisons may be made by disregarding harvest dates and selecting varieties having similar percentages of the various sieve sizes. For instance, the yields of Corneli 14 and Slenderwhite harvested October 14 might safely be compared with those of Bush Blue Lake 274, Cascade, White Seeded Tendercrop or Gallatin 50 harvested October 17.

The significance of careful observation

and proper scheduling at harvest is clearly shown by comparing the data of a variety on two harvest dates. As an example, consider the variety Provider on the October 11 and October 14 harvests. On October 11 this variety yielded 3.4 tons valued at \$256. The yield was made up of .68 tons of sieve 5 valued at \$50 per ton; 1.6 tons of sieve 4 valued at \$80 per ton; and .88 tons of sieve 3 valued at \$110 per ton. On October 14 the yield was 3.7 tons per acre valued at \$220, an increase in tonnage but a loss of \$36 per acre due to a lower grade. The sieve size had shifted to the larger sizes. There would be a further loss due to the cost of harvesting, handling and hauling of the

extra tonnage. Such comparisons of other varieties reveal a similar trend.

In the final analysis of the 1966 snap bean studies, careful observation and proper scheduling at harvest are essential. There were less than three days to harvest. There was only one day in which the proper sieve size-tonnage relation yielded the maximum dollar value to the grower and quality product to the processor. The varieties which appeared to possess the greatest potential as processing beans were Bush Blue Lake 274, Slenderwhite, Cascade, White Seeded Tendercrop and Gallatin 50. The variety Gallatin 50 had the slowest rate of seed development of all varieties tested.

Table 5. The relation of harvest date to yield, sieve size, and dollar value of several snap bean varieties.

Variety	Harvested October 11, 1966			Harvested October 14, 1966		
	Yield (tpa)	Sieve size (percent) 5 - 4 - 3	Value ¹ (dollars)	Yield (tpa)	Sieve size (percent) 5 - 4 - 3	Value ¹ (dollars)
Corneli 14	2.2	7-72-13	204	3.0	32-37-18	196
Harvester	2.0	3-33-33	128	2.9	26-40-21	197
Slenderwhite	2.4	0-31-41	168	3.4	28-32-27	236
Provider	3.4	20-46-26	256	3.7	40-26-17	220
Extender	2.8	53-26-14	160	4.1	65-21- 5	227
	Harvested October 14, 1966			Harvested October 17, 1966		
Bush Blue Lake 274	2.5	30-30-16	142	3.1	36-34-16	195
Cascade	2.8	40-34- 6	151	3.2	35-32-17	198
White Seeded Tendercrop	2.4	27-42-11	142	2.7	26-31-26	179
Gallatin	2.1	29-36-13	121	2.6	32-27-28	185

¹The dollar value was based on a price per ton of \$50 for sieve 5, \$80 for 4 and \$110 for 3.



Nitrogen Sources For Small Grains

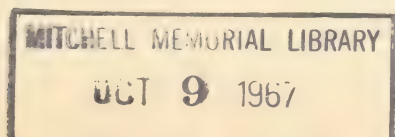
By W. F. JONES and J. D. LANCASTER

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NITROGEN SOURCES FOR SMALL GRAIN

By W. F. JONES and J. D. LANCASTER¹

During the past decade the use of urea has been increasing both as a solid and as a component of non-pressure nitrogen solutions for direct application, particularly the latter. The solutions sold in Mississippi usually contain 32% nitrogen. Approximately one-half of the nitrogen is derived from urea and the rest from ammonium nitrate. The solutions are marketed under such trade names as N-Sol-32 and Uran. Because they are highly competitive in price and can be transported, stored, and applied conveniently with a minimum of labor, solutions are gaining in usage and have already become a major source of nitrogen in Mississippi.

Urea is now priced competitively with ammonium nitrate. Fertilizer grade urea usually contains 45% nitrogen, which is 1.34 times as much as is contained by ammonium nitrate. Therefore, less labor is involved in handling urea.

Ammonium nitrate solution has been tested previously by the Mississippi Experiment Station and found to be as effective as ammonium nitrate applied in solid form for the production of oats for grain. Since urea is changed in soils by the enzyme urease to ammonium carbonate (a compound that decomposes to yield ammonia which is volatile), the loss of nitrogen as ammonia gas from urea, or solutions containing urea applied to the surface of the soil does occur under certain conditions, thereby reducing

the effectiveness of these fertilizers. Loss of ammonia has been reported greater from soils of neutral to alkaline reaction than from similar soils of acid reaction. This results because the high base content which produces alkalinity also reduces the ammonia holding capacity of the soil.

Urea-ammonium nitrate solution may be applied by spraying or dribbling. Application by spraying in the spring as opposed to dribbling could reduce the response to nitrogen because of "burning" of the foliage by the concentrated fertilizer solution.

Previous experiments have given results which seem to indicate that nitrate sources of nitrogen may be more effective for grain production than ammonium sources. If nitrate were more effective, it would be necessary to apply urea and the urea-ammonium nitrate solution earlier than nitrate sources so that nitrogen could be changed to nitrate by soil bacteria before it is utilized by the small grain during the maturing stage of growth. Urea solution (18% nitrogen) though not available as a fertilizer, was included to measure the influence, if any, of applying urea in solution on its effectiveness as a source of nitrogen.

Experimental Procedure

Based on the considerations just given, experiments to evaluate urea and urea-ammonium nitrate solution as sources of nitrogen for small grain forage and grain production were initiated in the fall of 1959 and continued through the spring of 1966. During this period, experiments were conducted at the Black Belt, Brown Loam, Pontotoc Ridge-Flatwoods, and Northeast Mississippi Branch Stations and at the Central Station at State College. The soil types at each location are shown in Table 1.

¹Appreciation is extended to R. E. Coats, Superintendent, Black Belt Station; B. C. Hurt, Jr., Superintendent, Pontotoc Ridge-Flatwoods Station; W. J. Gill, Brown Loam Station, and G. B. Welch, Agricultural Engineering Department, State College, for their contributions to this project.

The authors also wish to acknowledge the financial assistance provided by the Mississippi Chemical Corporation Stock Fund Grant.

For forage production, nitrogen was applied at the rate of 40 pounds per acre and for grain at rates of 30 and 60 pounds. Application dates were near March 1, March 15, and April 1 for grain and about March 1 for spring forage. Fall application of nitrogen for forage was made at seeding time which was usually during the period September 15 to October 15. In the fall, both surface and in-soil placement of the nitrogen was employed, but only surface application in the spring. Whether incorporated in the soil or left on the surface, the solid sources of nitrogen were broadcast uniformly over the plots.

Solution sources were applied either as a dribble or as a spray, or both. Dribble applications were made as small streams spaced 12 inches apart across the plots. A 3-gallon, garden-type, compressed

air sprayer was used to make the spray application.

Separate experiments were employed for fall and spring forage production and for grain. Each test site received an annual application of 60 lbs. each of phosphate (P_2O_5) and potash (K_2O) per acre which was incorporated during seed bed preparation, except that in a few instances a broadcast surface application was made about March 1 for grain experiments. The various treatments were arranged in a randomized block design with four replications.

In the experiments harvested for grain yield, the plot size was 14 by 75 feet. Yields were obtained by combining a swath through the center of the plot and weighing the grain obtained.

The plot size in experiments harvested

Table 1. Soil types on which experiments were located.

Location	Soil types	
	Grain tests	Forage tests
Black Belt Station	Houston clay	Houston clay
Pontotoc Ridge-Flatwoods Station	Atwood si loam	
Brown Loam Station	Grenada si loam	Calloway si loam
	Calloway si loam	Henry si loam
Central Station	Leeper si cl loam	West Point cl loam
Northeast Mississippi Station		Tuscumbia si cl loam

Table 2. Small grain yields as affected by source and rate of nitrogen and time of application.

Nitrogen treatment		Station and bushels of grain per acre					
Pounds per acre	Source ¹	Application time	Brown Loam (5) ²	Pontotoc Ridge (4)	Black Belt (5)	Central (1)	Weighted average
None			32	31	36	32	33
30	Ur	March 1	46	45	52	56	49
30	UrSol	March 1	47	45	49	50	47
30	ANUrSol	March 1	41	48	48	56	46
30	AN	March 15	45	53	48	50	48
30	Ur	March 15	46	49	49	46	47
30	UrSol	March 15	46	48	50	49	48
30	ANUrSol	March 15	47	46	45	53	46
60	AN	March 15	56	60	56	56	57
60	AN	April 1	46	55	49	49	50
60	AN	30-March 1					
		30-April 1	56	60	54	53	56
60	ANUrSol	March 1	49	58	56	68	55
60	ANUrSol	March 15	54	57	57	48	56
60	ANUrSol	April 1	47	57	48	45	50

¹All nitrogen solutions were applied as a dribble. AN = ammonium nitrates; Ur = urea; UrSol = urea solution; ANUrSol = urea ammonium nitrate solution.

²Numbers in parentheses refer to duration of experiment in years.

or forage was 8 by 20 feet. Forage yields were obtained by clipping a swath $3\frac{1}{2}$ feet wide through the length of each plot when the plants were 12 to 18 inches all. The weight of the green forage was recorded and a sub-sample was taken for moisture and nitrogen determinations. The nitrogen content of the forage was determined by the Kjeldahl procedure on a composite sample for each treatment and clipping at each location.

Results

Grain yield data for the different locations are shown in Tables 2 and 3. Grain

Table 3. Small grain yield as affected by source nitrogen. Average of March 1 and March 15 application dates for all locations.

Nitrogen source ¹	Average yield bushel/acre
Ammonium nitrate	48
Urea	48
Urea solution	48
Urea-ammonium nitrate solution	46

¹Nitrogen applied at the rate of 30 pounds per acre.

yields were increased by application of nitrogen at all locations and, with comparable dates of application, 60 pounds of nitrogen per acre gave higher yields than 30 pounds. However, the increase for 60 over 30 pounds was not as large as for 30 pounds over none.

Based on the average for all years and locations, each source of nitrogen gave an almost identical increase in grain yield, the exception being urea-ammonium nitrate solution which was slightly less than the others. The differences were not significant statistically, but they reflected a trend which was indicated in the forage experiments as well.

It may also be noted in Table 2 that earlier application of urea and of urea-ammonium nitrate solution than of ammonium nitrate was not required for maximum increases in grain yield from

these sources; also, that application as late as April 1 greatly reduced the effectiveness of the nitrogen whether applied as solid ammonium nitrate or as urea-nitrate ammonium solution. Splitting the application of ammonium nitrate—that is applying one-half about March 1 and the rest about April 1—did not increase its effectiveness for grain production over applying it all by or before March 15.

The effect on yield of spraying as opposed to dribbling the nitrogen solution is shown in Table 6. Grain and forage yields were the same for either method of application. Therefore, such additional “burning” of the foliage as may have occurred by spraying the nitrogen solution on did not reduce yields. Although the rate of nitrogen in this comparison was not as high as is recommended for small grain for grains, it is felt that the similar results would have been obtained if the recommended rate had been applied.

In view of the very favorable results obtained with urea, and because of its high nitrogen content and non-corrosive character, this fertilizer probably should gain favorable consideration for top dressing small grain by aerial application.

Forage yields for fall-applied nitrogen are shown in Table 4 along with nitrogen uptake data. As indicated by yield and nitrogen uptake, all sources were about equally effective. Slightly lower yields and nitrogen uptake were obtained with urea-ammonium nitrate solution, but the differences were not significant statistically by the usual techniques of analysis.

The influence of the different sources on yield and nitrogen uptake was unaffected by placement of nitrogen, in the soil or on the surface. Thus it is evident that no substantial loss of nitrogen as ammonia resulted from surface application of urea or urea-ammonium nitrate solution.

At the time the fertilizers were applied

Table 4. Forage yields with different sources of nitrogen applied in the fall.

Nitrogen treatment ¹	Station and forage yield as pounds of dry matter per acre	Weighted average	
		Dry matter yield lbs./A	Nitrogen uptake lbs./A
Source	Placement		
None	-----	787	793
AN	Surface	1232	1210
AN	In-soil	1262	1268
Ur	Surface	1386	1164
Ur	In-soil	1317	1168
ANUrSol	Surface	1148	1163
ANUrSol	In-soil	1210	1183
		245	245
		700	700
		1134	1134
		1219	1219
		1195	1195
		1185	1185
		1092	1092
		1153	1153

¹Nitrogen applied at the rate of 40 pounds per acre. AN = ammonium nitrate; Ur = urea; ANUrSol = urea-ammonium nitrate solution.

²Numbers in parentheses refer to duration of experiment in years.

Table 5. Small grain forage yields with different sources of nitrogen applied in the spring.

Nitrogen source ¹	Station and forage yields as pounds of dry matter per acre				Weighted average	
	Brown Loam (5) ²	Black Belt (4)	Northeast Miss. (4)	Central (3)	Dry matter yield lbs./A	Nitrogen uptake lbs./A
None	3009	2391	2131	1567	2402	26
Ammonium nitrate	4939	3950	2623	3251	4116	40
Urea	5121	4240	3772	3261	4267	41
Urea solution	4447	3619	3298	3195	3760	37
Urea-ammonium nitrate solution	4748	3484	3384	2994	3819	37

¹Nitrogen applied at the rate of 40 pounds per acre.

²Numbers in parentheses refer to duration of experiment in years.

Table 6. Efficiency of urea-ammonium nitrate solution as affected by method of application to small grain.

Nitrogen source ¹	Applied as	Yield in pounds of dry matter per acre		Oat grain yield—bu/A
		Fall application	Spring application	
Urea-ammonium nitrate solution	Dribble	1054	3898	67
Urea-ammonium nitrate solution	Spray	1091	3982	66
Check	-----	405	2977	40

¹Nitrogen applied at 40 pounds per acre for forage and 30 pounds per acre for grain.

in the fall, the surface of the soil was relatively dry, a condition which tends to prevent the enzymatic hydrolysis of urea to ammonium carbonate. With the occurrence of rainfall the unhydrolyzed urea would be washed into the soil where the ammonia would be retained when released following the hydrolysis of urea, thus reducing or preventing its loss.

Forage yields for spring-applied nitrogen are shown in Table 5. Greater differences were obtained among sources in

these than in the other experiments. Urea solid gave the largest increases both in yield and in nitrogen uptake, followed by ammonium nitrate, and then the nitrogen solutions, urea and urea-ammonium nitrate. The lower yield and nitrogen uptake associated with the nitrogen solutions apparently are not attributable altogether to loss of nitrogen as ammonia from surface-applied urea because these solutions—particularly the urea solution—were just as effective as ammonium nitrate for grain production when applied

t the same time as for spring forage production. Whatever condition was responsible for these differences evidently was of a temporary nature. Differential response to nitrogen sources as was observed here can be caused by difference in positional availability of the nitrogen, and this may have been a contributing factor. No other explanation seems logical.

The experimental sites were located on acid soils at the Brown Loam and Pontotoc Ridge-Flatwoods Branch Stations and on neutral to alkaline soils elsewhere. The soil types at each location are shown in Table 1. As may be noted from the yield data which also was confirmed by nitrogen uptake data not given, the performance of urea and the nitrogen solutions relative to ammonium nitrate was not affected noticeably by soil reaction in these experiments. Under more conducive conditions for hydrolysis of urea, significant loss of ammonia from the neutral to alkaline soils could have occurred, but such conditions apparently occur rather infrequently during the period when nitrogenous fertilizers are applied to small grain.

Summary and Conclusions

Field experiments were conducted to compare ammonium nitrate, urea, urea-ammonium nitrate solution, and urea solution for small grain forage and grain production during the period 1959-66.

Urea and ammonium nitrate were found to be equally effective for both forage and grain production, except that urea gave slightly but not significantly higher yields of forage for spring application. In the fall, method of placement

of the fertilizer on the surface or in the soil did not affect yield.

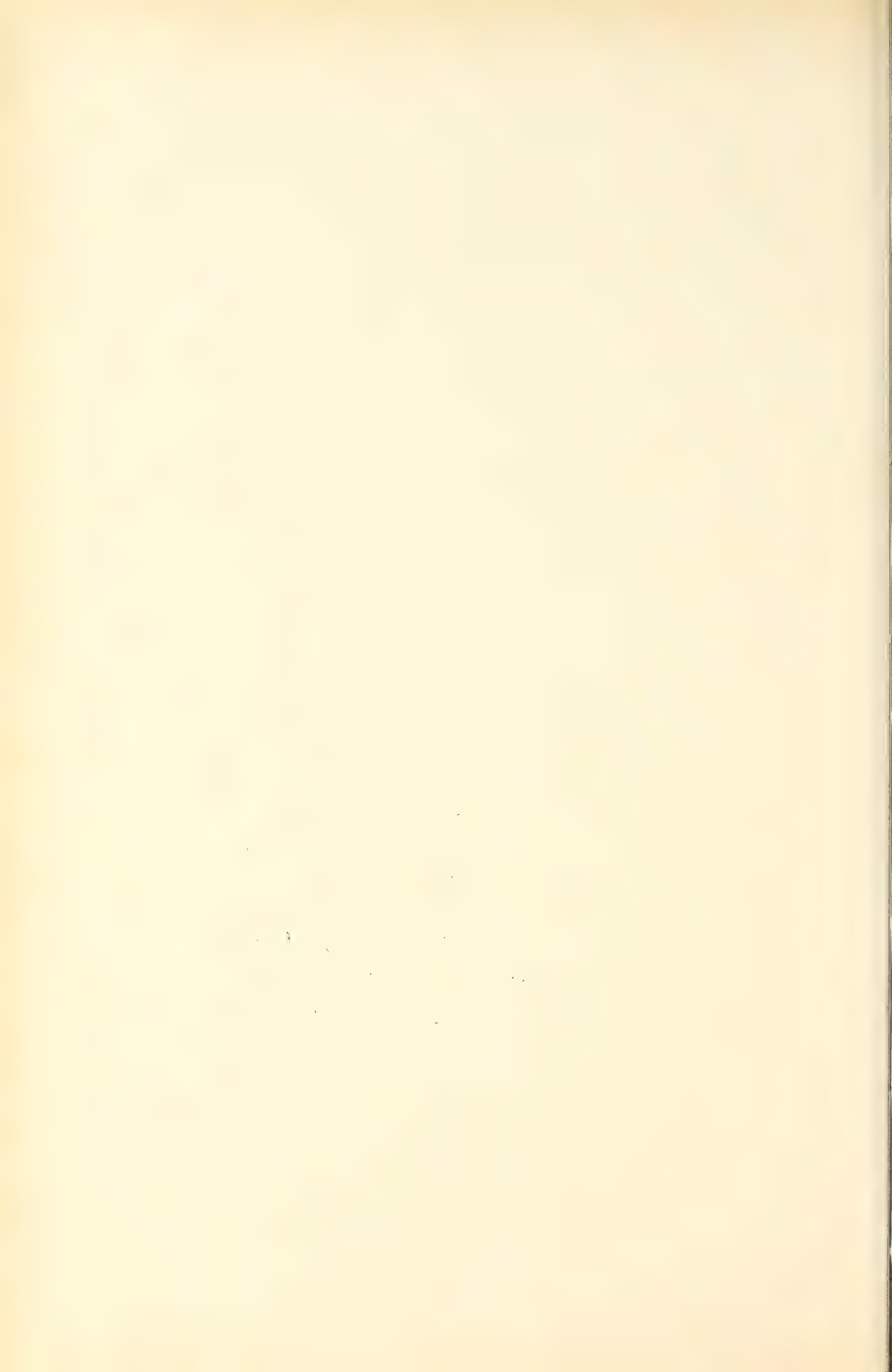
On the average, urea-ammonium nitrate solution produced slightly lower yields of grain and forage than did either urea or ammonium nitrate, but the greatest difference occurred with spring application for forage production. In this case an agronomic value equivalent to approximately 80 percent of that of ammonium nitrate was indicated. Urea solution top dressed in the spring gave forage yields similar to those obtained with urea-ammonium nitrate solution, but for grain production it was equal to ammonium nitrate and urea.

The failure of the nitrogen solutions to be as effective as the other nitrogen sources in some cases apparently was not associated altogether with volatilization of ammonia from urea applied to the soil surface. The more logical explanation is that the differences were associated with differences in positional availability which were of a temporary nature.

Application of the nitrogen solutions by spraying as opposed to dribbling did not affect yields, which indicates that "burning" of the foliage was not an important factor affecting response to nitrogen.

Because of its high nitrogen content and non-corrosive properties, solid urea would seem to be particularly suited for aerial application to small grain.

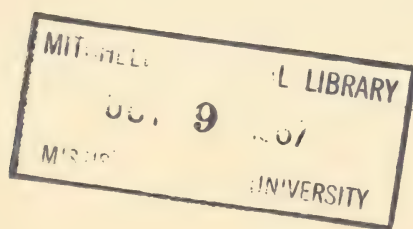
Although some differences were observed among fertilizers, it is concluded that all were satisfactory sources of nitrogen for small grain forage and grain production whether applied in the soil or as a top dressing irrespective of the soil reaction.



Behavior of Seed Cotton Exposed to Certain Atmospheric Conditions

By

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BEHAVIOR OF SEED COTTON EXPOSED TO CERTAIN ATMOSPHERIC CONDITIONS

By R. E. PARKER and W. P. CALDWELL¹

INTRODUCTION

Advancements in mechanized cotton production have had profound effects, both good and bad, on the quality of cotton lint as well as seed. These advancements have also caused more emphasis to be placed on the quality of cottonseed for planting purposes.

Growers can no longer afford to plant in excessive rate of seed and rely on hand labor to thin surplus seedlings. On the other hand, replanting is costly, especially when preemergence herbicides are applied. Thus, modern practices demand the use of high quality planting seed. Such seed have been scarce and frequently unobtainable in the Midsouth area in recent years.

Harvesting cotton with mechanical pickers often involves only one picking operation per season—after all bolls are open. In contrast to hand picking, this has resulted in an increased period of exposure of open bolls to field environmental conditions. Therefore, conditions which affect plant environment have a more important role than ever before in influencing the quality of cotton seed and lint harvested with machines.

The findings given in this report undertake to establish a relationship between cotton seed and lint quality and to show how preharvest environment, along with prolonged exposures, may affect the quality of both products.

REVIEW OF LITERATURE

Deterioration of cottonseed and lint has long been recognized as a major problem in producing high quality cotton. Field experiments for studying environmental effects on cotton's quality have been time-consuming and tedious because of the many variables involved.

One of the most thorough studies on field deterioration of cottonseed was done by Simpson and Stone (1). Their

experiments dealt with both Sea Island and short staple types of cotton at James Island, South Carolina, in 1931-1933. Bolls were tagged as they cracked open, then harvested 1 and 2 weeks later. Records of precipitation were kept during the period of open boll exposure. The results showed a definite negative correlation existed between viability of cottonseed exposed in the field and the amount of precipitation during the exposure period. Losses of 20 to 30 percent in viability were common after only 1 week of exposure to rainy weather. Losses as high as 40 percent were experienced during extremely adverse climatic conditions. Viability loss was greatest when rains occurred before the bolls had dried sufficiently to completely fluff out. These workers recommended saving seed for planting purposes from bolls which opened and dried

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The research described was done in cooperation with the Delta Branch, Mississippi Agricultural Experiment Station and the Agricultural Engineering Research Division, Agricultural Research Service, U. S. Department of Agriculture and is a part of a contributing project to Regional Project S-2.

only during conditions of no rainfall and low humidity. O'Kelly and Huss (2) in 1932-1933, near State College, Mississippi, confirmed the results of Simpson and Stone and, in addition, found a definite correlation existed between precipitation and oil milling characteristics of the cottonseed. Increased exposure made cottonseed less desirable for oil mill use.

Meloy (3), studying cottonseed quality from an oil mill viewpoint, in two adjoining Mississippi Delta counties during the 1943 harvest season, observed a higher rate of field deterioration in one county than in the other, even though both received approximately the same amount of rainfall. He postulated that the difference in seed quality might be due to higher relative humidity during seed maturation in the one county than in the other. The county having the lower quality seed have many rivers, creeks and swampy areas surrounding the cotton fields. This tended to raise the relative humidity in the microclimate around the boll. Unfortunately, no climatological data appears to have been recorded in these counties for that year, so his hypothesis cannot be verified.

In the Anglo-Egyptian Sudan in 1952, Anthony and Tarr (4) found a considerable difference in the degree of seed deterioration between early-picked and late-picked seeds. Local weather conditions during the harvest season were quite humid with a considerable amount of rainfall. These authors attributed the deterioration in seed viability to attack by insects followed by secondary invasion of fungi.

A review of research work connected with experiments on cotton fiber deterioration shows that the same factors which affect seed deterioration also influence the quality of the lint.

Riley and Williamson (5) found that cotton in defoliated fields dried out quicker in the morning and regained

moisture later in the afternoon than did cotton in undefoliated fields. Further studies by Wooten et al. (6) showed that during an 18-day period in the Mississippi Delta, minimum humidities averaged 8.8 percent lower in defoliated fields than in undefoliated fields. They conclude that leaf cover was a major factor influencing humidity in cotton fields.

Parker (7) found that when seed cotton grown in the Mississippi Delta was stored in an atmosphere of high humidity for $2\frac{1}{2}$ months, 90 percent of the lint was infested or destroyed by microorganisms. It was known that most of the micro-organisms identified grow and reproduce more rapidly in environments of high humidities.

At Thorsby, Alabama, Scarsbrook et al. (8) found that the combination of high rates of nitrogen and moisture increased the incidence of boll rot in the lower portions of the plant. Jarman (9) working in the Sudan, found in studying the microclimate of cotton fields that temperature tended to increase with height above ground, while relative humidity decreased. Similar investigations by Nelson (10) showed that fibers from bolls from the upper portions of the cotton plant were stronger than those from the lower portion of the plant under conditions of high nitrogen fertilization and subsequent dense plant growth. Peebles et al. (11) also reported that fiber strength of cotton decreased with closer plant spacing under irrigated conditions in Arizona.

Studies by Montgomery and Wooten (12) revealed that lint grade, fiber length, strength, and length uniformity—were lower for cotton harvested in midseason than for early-harvested cotton in the Mississippi Delta. Relative humidity at time of picking had no apparent effect on these properties. Yarn strength and yarn break factor also correspond to the fiber properties.

MATERIALS AND METHODS

Description of Experiment

The experiment was conducted entirely under controlled environmental conditions at the Seed Technology Laboratory, Mississippi State University. Only three independent variables were included—relative humidity, temperature, and length of exposure. Dependent variables measured were: Seed viability and vigor, lint color, and fiber strength, length and fineness.

The test procedure consisted of storing bolls of cotton in known environments for a period of 8 weeks and studying the effects of specific climatic factors. The environments produced are shown in Table 1.

Table 1. Environments compared in cottonseed study.

Treatment number	Temperature + relative humidity		R.H. Percent
	Degrees F.		
1	110	50	60
2	108	68	40
3	106	86	20
4	130	50	80
5	128	68	60
6	126	86	40
7	150	50	100
8	148	68	80
9	146	86	60
10	168	68	100
11	166	86	80

Seed cotton samples were taken from each environment at 9 intervals (exposure periods from 0 to 8 weeks in 1-week intervals). Because of the size of the seed cotton samples and the shortage of storage facilities, no replicated measurements of fiber properties could be made. However, two seed samples of 50 seed each were taken after each exposure period ended. The lint from the two samples was then blended for further fiber tests. Correlations were then computed for the lint quality measurements and their corresponding seed quality measurements.

Equipment, Instruments, and Measurements

The specific environments were obtained by placing known concentrates of glycerin and water in drums containing the seed cotton samples. The drums were then sealed. Relative humidity in the drums was controlled by varying the amount of glycerin in the water. Pure water would completely saturate the air volume while pure glycerin would absorb almost all of the water vapor from the air. The desired humidities were achieved by trial and error mixing of the water and glycerin.

To insure that all bolls were the same age for the test, they were pulled from the stalk when they were just beginning to crack. It therefore required some time before the moisture content of the seed cotton in the boll equalized with the atmosphere inside the drums.

The temperature inside the drums was controlled by placing the drums in controlled - temperature rooms. Temperatures of 50°, 68°, and 86°F. were maintained while relative humidities of 20, 40, 60, 80, and 100 percent were held constant. Only 11 of the 15 possible combinations of temperature and relative humidity were employed in the test. The combinations in which both temperature and relative humidity were so low that deterioration was certain **not** to occur and those in which both temperature and relative humidity were so high that deterioration was certain **to** occur were deleted.

A Nickerson-Hunter Cotton Colorimeter was used to measure lint color in terms of percent light reflectance and degree of yellowness. The combination of reflectance and yellowness measurements was then converted into universal standard grades of American Upland Cotton by using the USDA, ARS Color

diagram for Nickerson - Hunter Cotton Colorimeters (spinlab model).

Fiber upper half mean length (inches) was measured by a Servo-Fibrograph and fiber fineness was measured by a Micronaire. Fiber strength was measured by a Pressley Fiber Strength Tester and was reported as a strength index (grams per tex).

All of the lint and fiber measurements were made on the same sample of cotton which was identified according to its treatment. The seed were also saved from the same seed cotton samples. All of the seed cotton samples were ginned with a laboratory model roller gin. To insure the most accurate average lint and fiber measurements, it was necessary to blend the lint samples with a USDA Ginning Laboratory model lint blender.

Seed quality evaluations were determined from counts of seed viability and vigor for each sample. Two 10- by 15-inch germination towels were first moistened with tap water. Fifty seeds were placed radicle-end-down in 5 rows of 10 seeds each on one of the towels and were covered with the remaining towel.

The exposed ends were then folded over. Twelve samples were placed in a stack in a plastic crisper box with a tight fitting cover. The crisper was then placed at a 45° inclination inside a 30° C. constant - temperature germinator. Counts were made at 24-hour interval beginning on the second day after planting. Normal seedlings with radicle over 25 mm. in length were removed and recorded. The counting procedure was terminated on the sixth day after planting. The number of remaining seeds and seedlings were recorded as abnormal seedlings or dead seeds.

Calculation of a vigor index was made according to the method described by Throneberry and Smith (13). The number of seedlings removed each day for each replication was multiplied by the reciprocal of the time in days since planting. A summation of the daily vigor increments for 6 days was made and referred to as a vigor index based upon 100 seed planted. The summation of the total number of normal seedlings (those with radicles over 25 mm. in length) removed during the germination period was recorded as the viability and converted to a percentage of viability.

RESULTS

Seed Viability

As illustrated in figure 1, seed cotton can be stored in an environment of 50° Fahrenheit at a maximum of 60 percent relative humidity with no adverse effects on seed viability. Also, seed cotton can be stored in an environment of 60 percent relative humidity at a maximum of 50°F. with no effects on seed viability.

Temperature had a much more pronounced effect on seed viability than did relative humidity. An increase in relative humidity from 60 percent to 80 percent within the 50°F. chamber affected viability only after approximately 3 weeks of exposure. On the other

hand, an increase in temperature from 50°F. to 68°F. within the 20 percent relative humidity environment affected seed viability during the first week of storage.

Seed viability was reduced to near zero after only 1 week of exposure of seed cotton to a temperature of 86° F. regardless of the relative humidity. In addition, seed cotton was successfully stored, with no adverse affect on seed viability, at a maximum temperature of 68° F. only when the relative humidity was 40 percent.

In general, considering only seed vi-

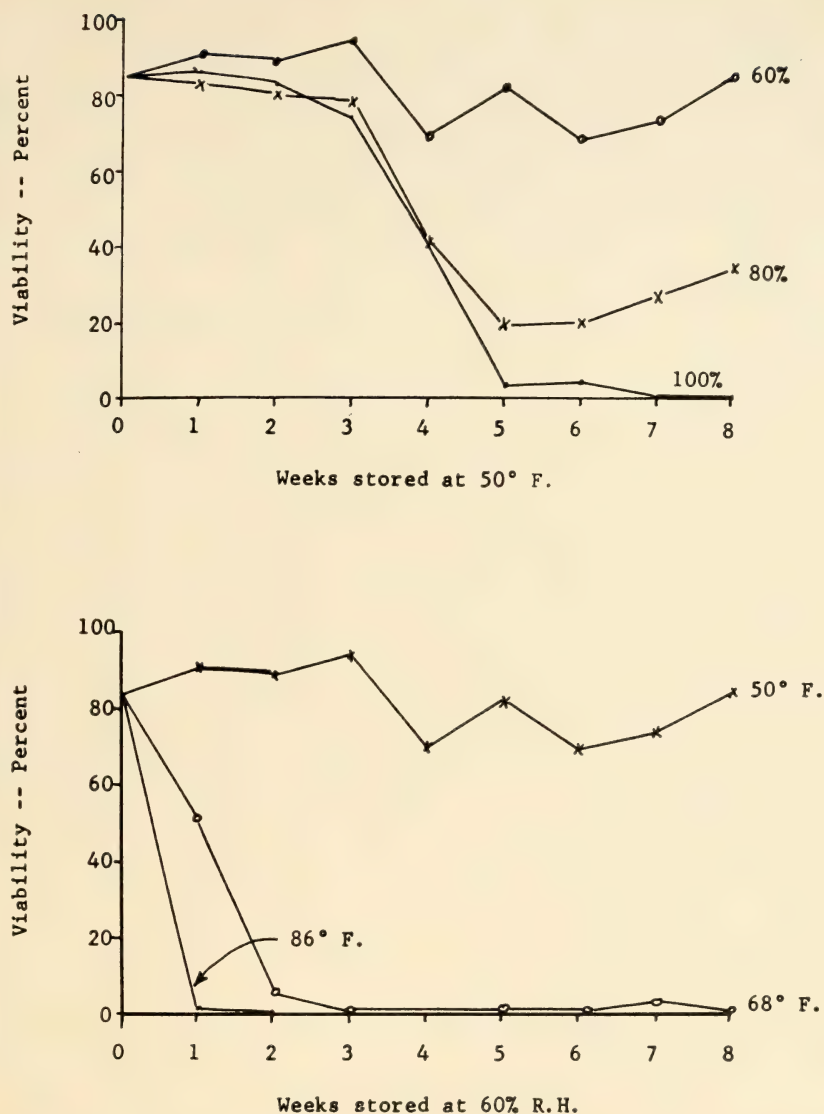


Figure 1.--Effects on viability of seed when seed cotton was stored for 8 weeks in certain environments.

ability, seed cotton can be stored safely in environments made up of temperature plus relative humidities not exceeding 110. The exception to this rule of thumb occurred when seed cotton was stored

at 86° F. and 20 percent relative humidity. In this case, viability dropped from 84 percent to 13 percent after only 1 week of seed cotton storage or exposure.

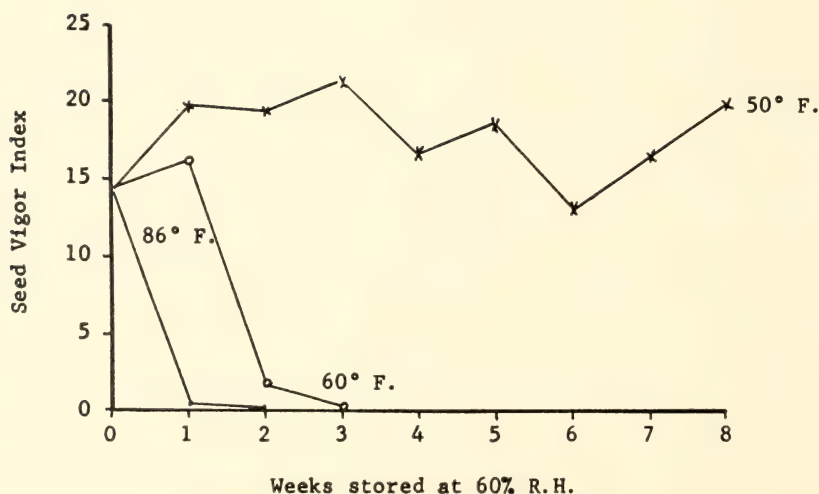
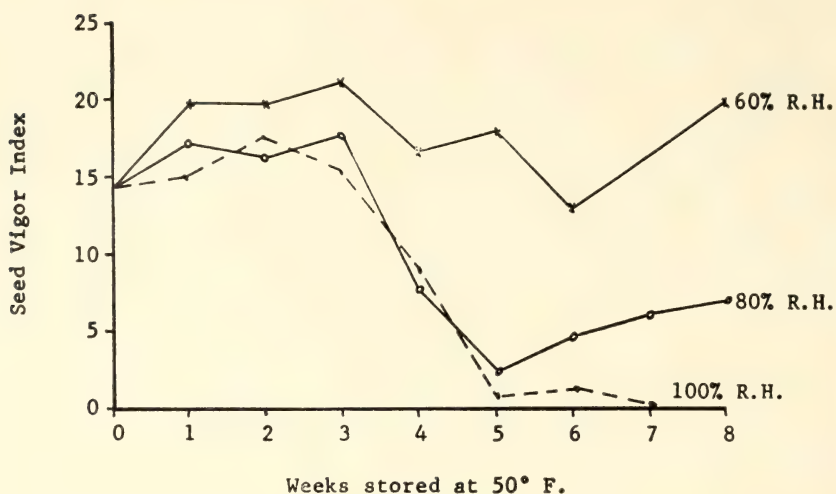


Figure 2.--Seed vigor response when seed cotton was exposed to certain controlled environments in 1961.

Seed Vigor

Seed vigor response to temperature and relative humidity was similar to seed viability response (figure 2).

Again, seed vigor was not affected until 3 weeks of exposure of seed cotton to relative humidities of 80 and 100 percent when the temperature was 50° Fahren.

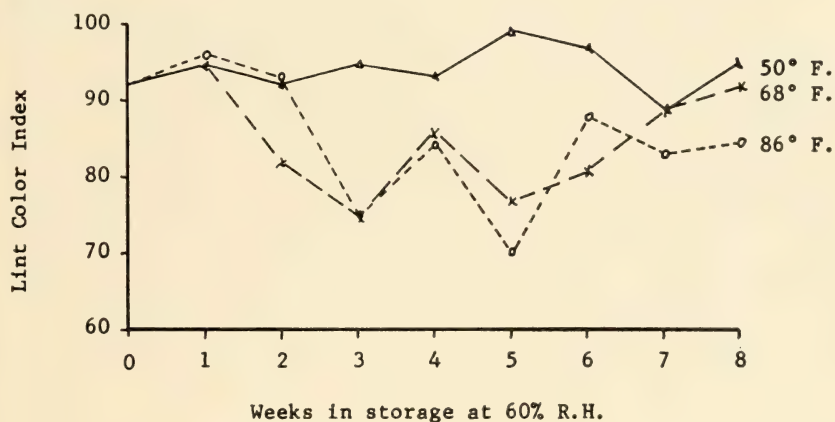
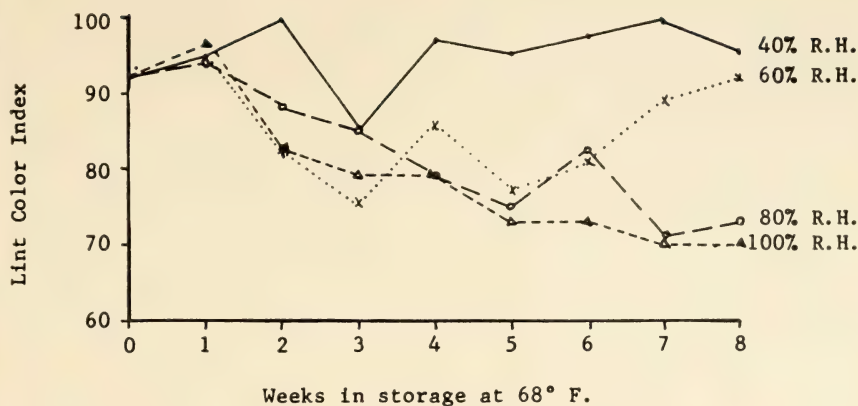


Figure 3.--Graphical illustration of how lint color was affected by certain temperatures and relative humidities in 1961 study of seed cotton exposure to controlled environments.

heit. Exposure of seed cotton to a temperature of 86° F. adversely affected seed vigor regardless of the relative humidity. Seed cotton was stored successfully at a maximum temperature of 68° F. with no adverse effect on seed vigor only when relative humidity was 40 per cent.

The rapid deterioration of seeds from

bolls stored at all humidity levels at 86° F. may be attributed to the fact that when the bolls were placed in the specific environments, they were high in moisture content, having just begun dehiscence. A report of time was necessary for the moisture of the seeds to come to equilibrium with the ambient relative humidity. During this period

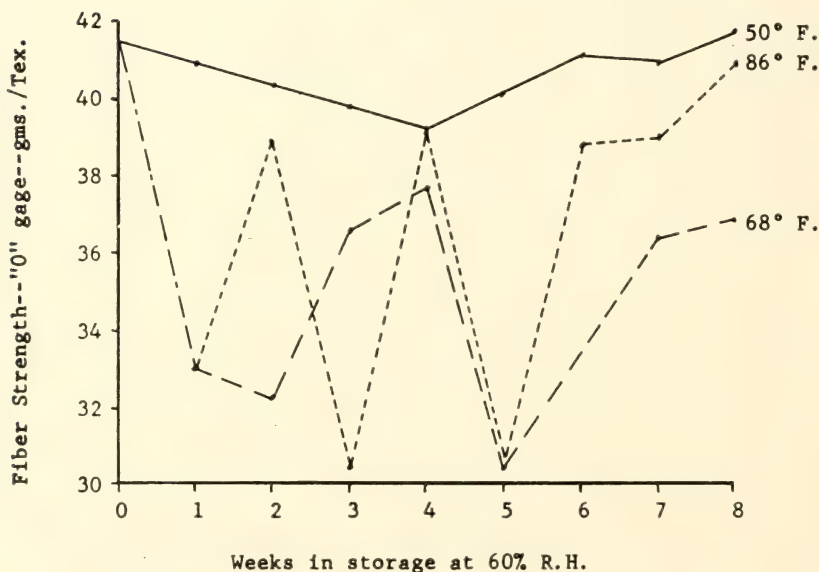
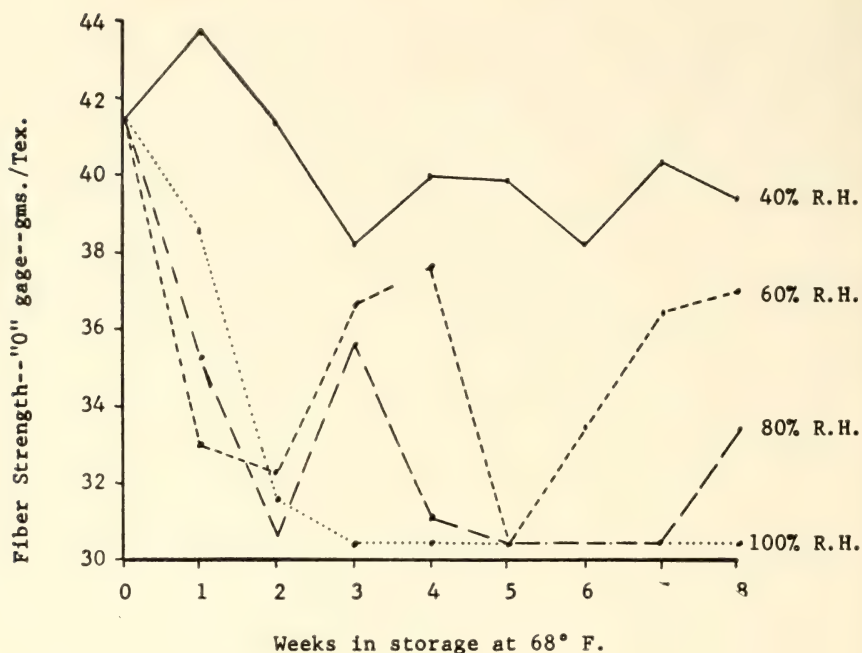


Figure 4.--Fiber strength response to certain temperatures and relative humidities in 1961 study of seed cotton exposure to controlled environments.

the high temperature and high moisture content of the seed undoubtedly contributed greatly to deterioration in both vigor and viability.

Lint Color

Since only one lint sample was extracted from each environment chamber after each week of seed cotton storage, lint color measurements were very erratic, thereby making it difficult to decipher true trends in lint color behavior. However, the probable primary cause of lint color changes was micro-organism infestation as noted by visual inspection of the lint samples. The difference in microbial activity between bolls of the same treatment was probably responsible for the wide fluctuations in lint color measurements (figure 3).

It appeared that lint color remained the most stable when seed cotton was stored in chambers of 68° F. and 40 percent relative humidity or 50° F. and 60 percent relative humidity. Lint color behavior was similar to that of seed viability and vigor. For sums of temperature plus humidities over 110, lint color characteristics decreased with storage of seed cotton over 1 week. It may be noted that neither temperature nor relative humidity had any apparent effect on lint color during the first week of seed cotton storage. In addition, based upon a comparison of the two graphs of figure 3, lint color responded more to relative humidity than to temperature. This behavior may be somewhat different for temperatures higher than those used in this particular study.

Fiber Strength

As in the case of lint color, fiber strength varied widely from week to week except for the environments of 40 percent relative humidity — 68° Fahrenheit and 60 percent relative humidity—

50° Fahrenheit. Also, fiber strength was apparently more closely associated with relative humidity than with temperature as indicated in figure 4. However, for all those combinations of humidity plus temperature over 110, fiber strength was drastically reduced the first week of seed cotton exposure. It should be pointed out that after 3 weeks of exposure of seed cotton to the environment of 100 percent relative humidity and 68° Fahrenheit, fiber strength was too low to be measured by the Pressley. The points on the graph after 3 weeks of exposure were plotted slightly lower than the lowest fiber strength measured by the Pressley.

Fiber Length

Fiber length behavior with respect to seed cotton exposure to known temperatures and humidities in 1961 was closely related to fiber strength. Figure 5 indicates that fiber upper half mean length was virtually unaffected by seed cotton exposure to environments of 40 percent relative humidity — 68° Fahrenheit and 60 percent relative humidity and 50° F. Also, fiber length decreased the first week of exposure of seed cotton to all environments composed of relative humidity plus temperature combinations over 110. Again, as in the case of lint color and fiber strength, fiber length was apparently more closely associated with relative humidity than with the temperatures employed in this particular test.

Fiber Fineness

Fiber fineness as measured by the Micronaire did not respond as quickly to seed cotton exposure time as did lint color, and fiber length and strength. Fiber fineness was also not as radically affected by moderately high humidities and temperatures.

Figure 6 indicates that no apparent

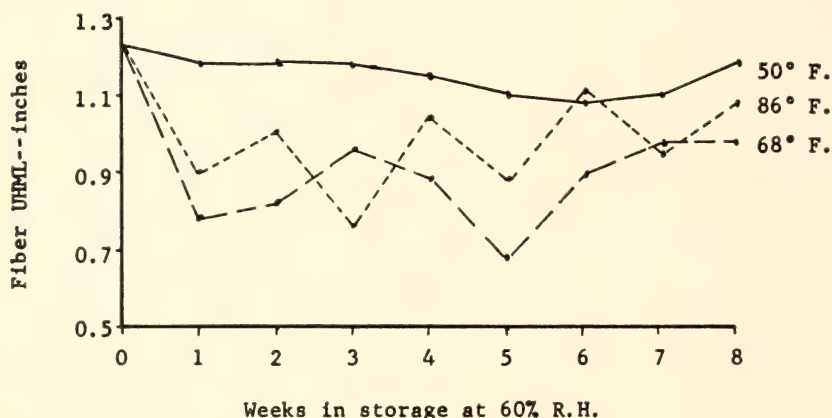
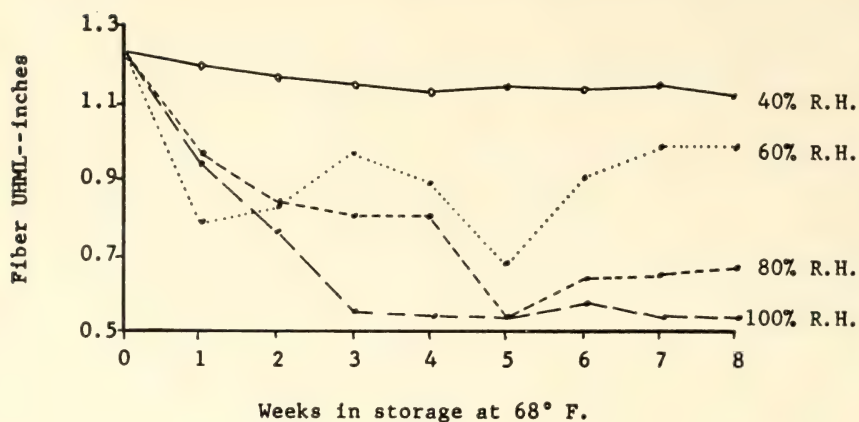


Figure 5.--Effect of certain environments on fiber upper half mean length (UHML) when seed cotton was exposed for 8 weeks.

change in fiber fineness resulted when seed cotton was exposed to a maximum temperature of 68° F. and a maximum relative humidity of 60 percent. Although exposure of the seed cotton to the high temperature of 86° F. at 60 percent relative humidity lowered the Micronaire reading somewhat, this reduction did not occur until after 3 weeks of exposure.

Again, the effect of relative humidity on Micronaire reading was more pronounced than the effect of temperature. It should be pointed out that Micronaire readings indicate the resistance to the passage of air under specified pressure through a specified weight of cotton when it is compressed to a specified volume. Air flow resistance is a func-

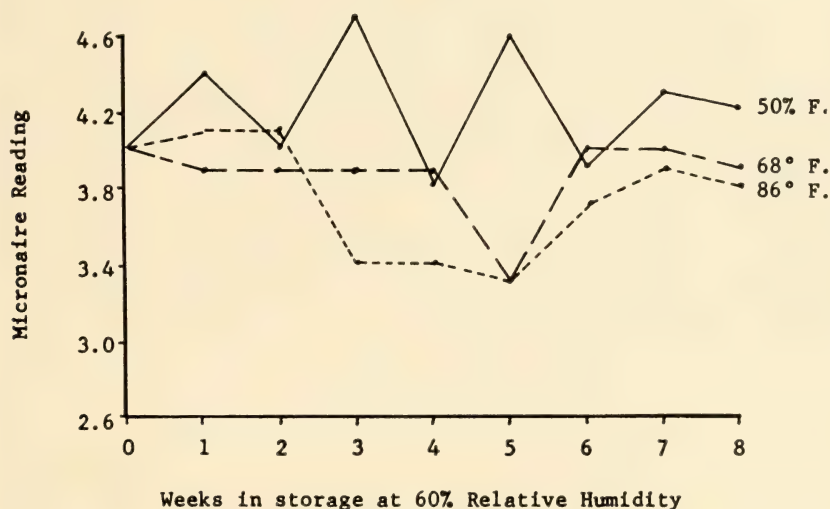
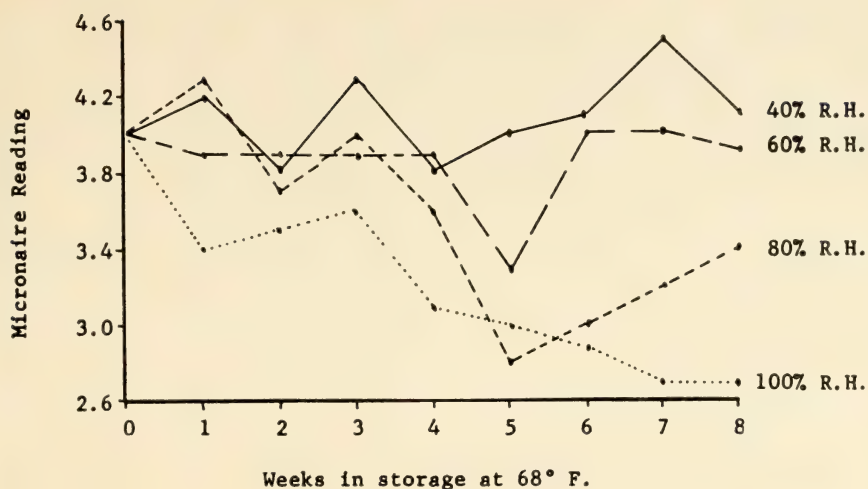


Figure 6.--Fiber fineness (Micronaire) as affected by seed cotton exposure to certain controlled environments.

tion of fiber surface area and void space. Thus, the instrument readings are related to the weight of fibers per unit length. This ratio is directly related to fiber coarseness.

On the other hand, if the fiber sur-

face area is "rough," the Micronaire readings do not give a true indication of fiber fineness. For instance, bacterial blight tends to "glue" fibers together and *aspergillus flavus* tends to break up the fiber outer walls. Both of these con-

ditions would have a profound influence on air-flow resistance (would increase resistance). The Micronaire would indicate a lower ratio of weight to length and consequently a finer fiber.

Destruction of fibers by micro-organisms during exposure to the higher temperatures and humidities most likely brought about the reductions in Micronaire readings rather than any actual change in fiber fineness.

Correlations

Correlation coefficients were computed for lint quality — seed quality comparisons for complete environment study. All correlation coefficients were positive and highly significant as pointed out in table 16. The correlations represent comparisons of seed vs. lint measurements for each week of seed cotton storage in each of the 11 environments. Thus, each coefficient represents a comparison of lint and seed quality measurements from 89 seed cotton samples.

It is emphasized that these significant correlations may hold true only when seed cotton is exposed to the temperatures and relative humidities employed in this test. The lint and seed quality relationships may not be repeated consistently in field tests. Certain variations in the field, such as agronomic and biological factors, would be expected to influence the relationship between lint and seed quality.

Table 2. Correlation coefficients between cotton lint and seed quality measurements from the controlled environment study of 1961.

Factor compared	r
Seed viability/seed vigor	.985**
Seed viability/lint color	.521**
Seed viability/fiber strength	.502**
Seed viability/fiber upper half mean length	.544**
Seed viability/fiber fineness	.534**
Seed vigor/lint color	.507**
Seed vigor/fiber strength	.487**
Seed vigor/fiber upper half mean length	.525**
Seed vigor/fiber fineness	.395**

**Denotes significance at the 1-percent level of probability.

SUMMARY AND CONCLUSIONS

Seed cotton was exposed for 8 weeks to controlled environment conditions consisting of temperatures ranging from 50° F. to 86° F. and relative humidities ranging from 20 to 100 percent. Samples for seed and lint quality measurements were taken from each environment chamber after each week of exposure in succession.

Deterioration of both lint and seed resulted when the combination of temperature and humidity exceeded 110. Lint deterioration appeared to be more closely associated with relative humidity than with temperature while seed deterioration appeared to be more closely associated with temperature. All lint quality factors measured were significantly related to all seed quality factors meas-

ured. Thus the production of high quality lint is synonymous to the production of high quality seed.

Based on the results of this study, it is concluded that cotton seed and lint quality can be preserved to some extent by utilizing cultural practices which tend to reduce relative humidity and promote faster drying of the soil and seed cotton. Such practices include proper drainage, skip-row planting, and defoliation. Other practices such as heavy irrigation and high fertilization rates would be expected to have detrimental effects on quality because of subsequent increases in plant density and foliage thickness.

For high quality, it is also most important that seed cotton be harvested as soon after opening as possible.

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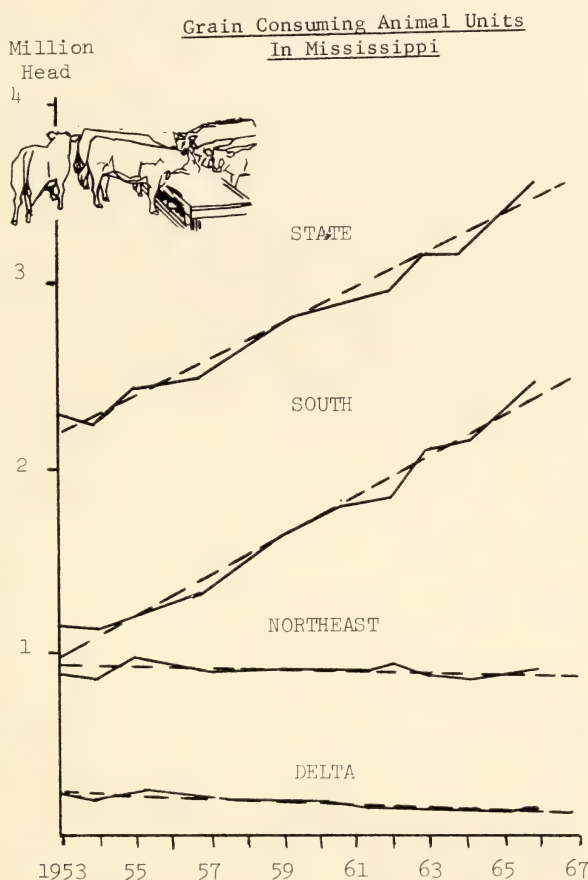
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Mississippi

FEED GRAIN USE IN 1964

WITH PROJECTIONS FOR 1975



MISSISSIPPI STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION

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STATE COLLEGE

MISSISSIPPI

MAY 8 1969

PREFACE

This report is a part of Mississippi's contribution to the Southern Regional Grain Marketing Project, SM-29, "Optimal Adjustments of Southern Grain Marketing Facilities to Present and Future Conditions." Other agencies cooperating in this research are the Agricultural Experiment Stations in Alabama, Arkansas, Florida, Kentucky, Louisiana, North Carolina, South Carolina, and Tennessee; the Economic Research Service and the Farmer Cooperative Service of the USDA, and the Agricultural Resource Development and the Navigation Economics Branches of the Tennessee Valley Authority.

This report is the second publication on a state basis arising from the study. The first was **Mississippi Grain Movements During 1964 with Comparison with 1960**, Mississippi Agricultural Experiment Station, AEc. M. R. No. 51, November 1966. Numerous regional bulletins will be forthcoming from the project.

Data in this report show the livestock-poultry-feed grain economy of Mississippi as it appeared in 1964. The primary purpose of the study was to project feed grain requirements and production to 1975. The projections are only as accurate as the past trends are as indicators of the future. If future conditions change at a different speed than in the past or in a different direction, projections will not become reality. Estimates for substate areas are probably not as accurate as those for the entire state. Also, it was felt that the aggregative estimates for all types of animals and grains are more likely to be realized than those for a specific grain or type of animal.

ACKNOWLEDGMENTS

The authors are indebted to so many individuals in the Mississippi Agricultural Experiment Station and the Cooperative Extension Service that all cannot be listed. Special appreciation is extended to the feed and grain dealers who supplied the grain-movement data.

The authors express their appreciation to V. G. Hurt, D. W. Parvin, J. H. Simpson, Jr., L. D. Welch, and C. M. Wells, Jr. of the Department of Agricultural Economics for their critical review of the manuscript.

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SUMMARY AND CONCLUSIONS

The purpose of this study was to estimate the quantities of feed grains required by livestock and poultry in 1964 and to project these quantities and grain production in 1975. For this analysis, the state was divided into three areas.

Two methods for estimating feed ingredient utilization were developed. One method used a net flow concept obtained from grain movements adjusted for production and changes in stocks. The second method was a ration approach which represents the quantities fed animals for one year. The latter approach with animal number projections was used to estimate feed requirements for 1975.

Approximately 58 million bushels of corn were available in Mississippi in 1964. A net of approximately 34 million bushels came from other states. Approximately 65 percent of the available corn supply was in the southern area of the state, 32 percent in the northeast, and the remaining 3 percent in the Delta.

Utilization of corn by livestock and poultry was estimated to be approximately 56 million bushels in 1964. By 1975, over 72 million bushels will be required with poultry consuming more than 46 million bushels.

In 1975, grain marketing facilities will be required to handle substantially more grain than in 1964. Over 2 million bushels of grain sorghum and over 3.5 million bushels of oats were fed in 1964. Grain sorghum needs by 1975 are estimated at nearly 6 million bushels while oat requirements are expected to remain approximately the same as the 1964 level. Corn, grain sorghum, and oat production in the state are expected to decline from 1964 levels. For feed utilization, approximately 65 million bushels of corn, more than double the 1964 quantity, will be needed from other sources. Total requirements of corn for feed are expected to increase from 56 to 72 million bushels. Required grain sorghum from other states will be nearly 6 million bushels in 1975 compared with less than 2 million bushels in 1964. Mississippi in the past produced more oats than were fed in the state. Indications are that by 1975 production will be nearly 4 million bushels short of utilization. Of course, some substitution may take place among grains, but the total consumed will likely confirm to the estimates made. The total volume will likely be higher in 1975 than that estimated because some grain will be used for purposes other than feeding livestock and poultry.

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¹Details of the grain movement survey were published separately as **Mississippi Grain Movements During 1964 with Comparison with 1960**, Mississippi Agricultural Experiment Station AEc. M. R. No. 51, November 1966.

²Linear regression using time as the independent variable was used for making projections. In those cases where some of the projections for the individual substate areas were negative, the state projections were assumed to be the sum of the individual substate estimates which were positive.

MISSISSIPPI FEED GRAIN USE IN 1964

WITH PROJECTIONS FOR 1975

John C. Wilson, Robert J. Martin, and Travis D. Phillips*

INTRODUCTION

The livestock, poultry, and feed grain sectors of Mississippi's economy have experienced rapid changes in recent years. Poultry and beef cattle have been replacing dairy cattle and hogs. Soybean production has been replacing that of corn and oats.

As a result of these changes, only a small proportion of the feed grain fed in Mississippi is produced by the feeder. Thus, the flows of grains and feed ingredients through market channels have shown tremendous increases.

Changes presently underway are likely to continue into the future. Individuals who handle grain and grain products need information to help them adjust their marketing facilities to future production and feed requirements.

The purpose of this publication is to (1) show changes in production of grain and livestock and poultry numbers during 1953-66, (2) project grain and animal numbers for 1975, (3) estimate the consumption of feed ingredients for 1964, and (4) project feed grain and feed ingredient requirements for livestock and poultry for 1975.

For purposes of this study, Mississippi was divided into three substate areas (See Figure 1).

The method of analysis consisted of making current estimates of feed grain production and requirement balances

and projecting these data to 1975 to indicate the expected balances at that time. For the current estimates of feed grain and other feed ingredient requirements, two approaches were used.

Utilization estimates were made by measuring net flows of grains for each of the substate areas, adding production within each area, and adjusting for changes in stocks.¹

A second estimate was made by using rations considered by Agricultural Experiment Station and Cooperative Extension Service personnel to be typical of those being fed livestock and poultry in the states. The appropriate numbers of animals were multiplied by the quantities of each ingredient in the respective rations.

Major differences between these two estimates of utilization were reconciled, and current rations were adjusted to the expected rations for 1975. Animal numbers were projected for purposes of making the estimates of 1975 utilization.

In some cases the projected quantities of both grains and animal numbers indicate none will be produced in some substate areas by 1975.² Although production of these items probably will not completely disappear in these areas, for purposes of further computation these quantities were assumed to be zero in 1975.

Table 1. Animal numbers by substate areas of Mississippi, 1964 numbers and 1975 projections.

Type livestock	Delta (I)		Northeast (II)		South (III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
thousand head								
Grade 'A' milk cows	1	0	52	47	77	55	130	102
Other milk cows	6	0	140	24	42	0	188	24
All other dairy animals	5	0	105	52	80	28	190	80
Beef cows	109	116	414	592	534	693	1,057	1,401
All other beef animals	83	79	315	429	407	500	805	1,008
Beef cattle fed	2	2	18	21	24	29	44	52
Hogs raised	86	33	256	258	224	180	566	471
Sheep and lambs	7	0	6	70	20	0	33	0
Horses and mules	12	12	70	70	59	59	141	141
Hens and pullets	558	770	2,732	4,314	7,863	14,498	11,153	19,582
Chickens raised	551	368	2,700	2,822	7,768	11,583	11,019	14,773
Broilers raised	2,481	4,871	11,151	21,354	143,306	272,231	156,938	298,456
Turkeys raised	6	0	90	122	20	0	116	122
All other animals	8	5	43	43	108	168	159	216

TRENDS IN ANIMAL NUMBERS

Types of animals were broken down through 1966 were used for making as completely as published data would permit. Data for the period 1953 projections to 1975.

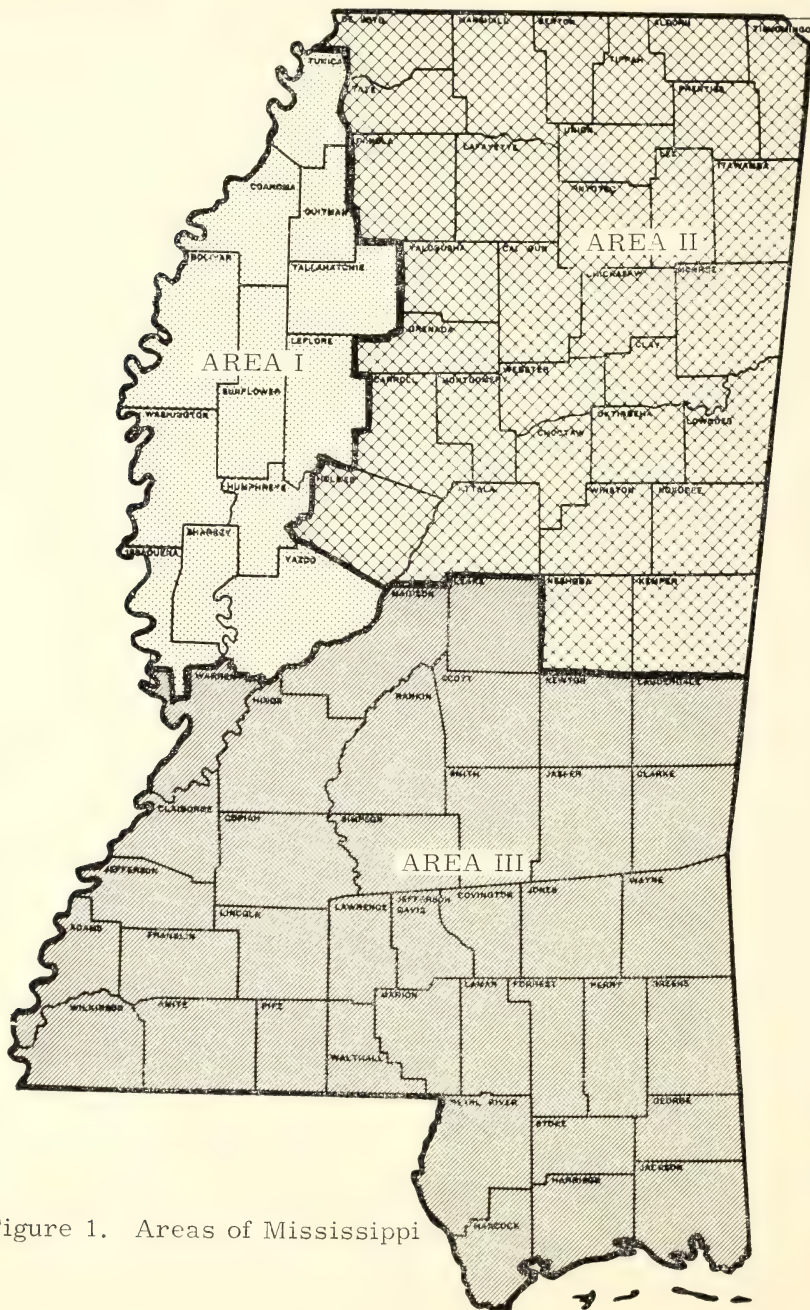


Figure 1. Areas of Mississippi

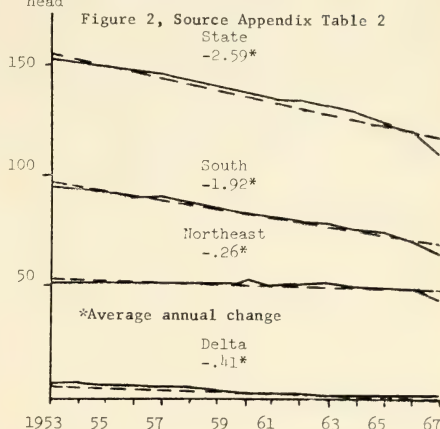
Dairy Cattle

Published data do not distinguish between Grade A herds and other milk cows. Since there are rather wide differences in trends in numbers of these two types of dairy herds (Figures 2 and 3), it was deemed necessary to estimate numbers for each category even at the expense of possible inaccuracies.³

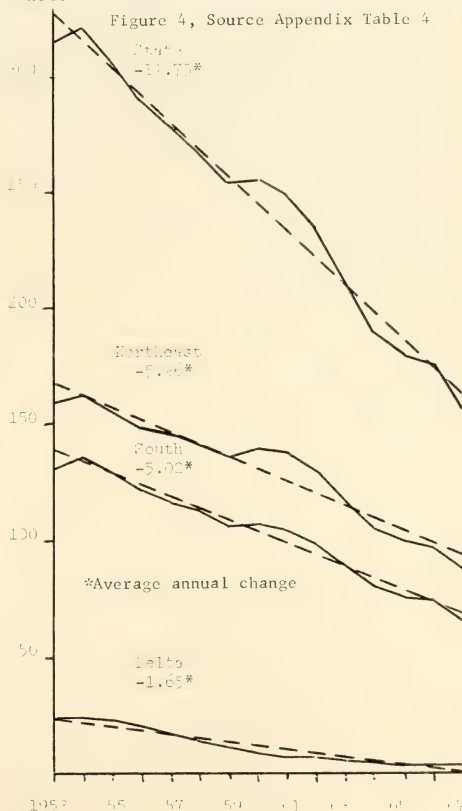
The number of Grade A cows has decreased in the Delta (Area 1) and southern areas (Area 3) but have remained rather stable in the northeastern area (Area 2) (Figure 2). The rapid decline in numbers of other milk cows (Figure 3) can be expected to continue to the point of disappearing by 1975 except for about 24,000 head in the northeastern area (Table 1).

Dairy cattle less than two years old and bulls were classified as other dairy animals (Figure 4). Since reported data do not distinguish between dairy and beef bulls, they were allocated in proportion to dairy and beef cows. Other dairy cattle were allocated to substate areas in proportion to the dairy cow numbers in the respective areas.

GRADE "A" MILK COWS

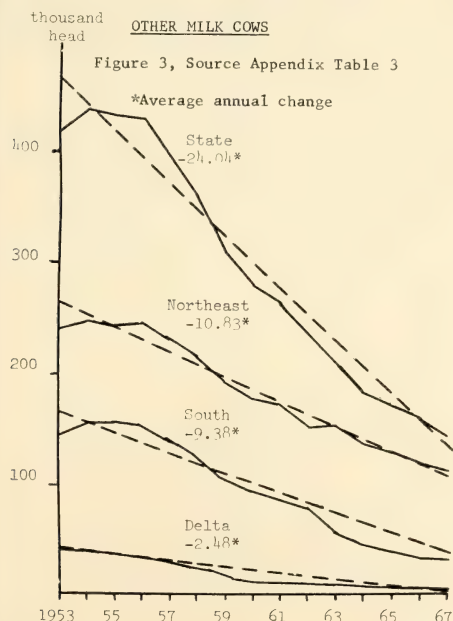


OTHER DAIRY ANIMALS



OTHER MILK COWS

Figure 3, Source Appendix Table 3

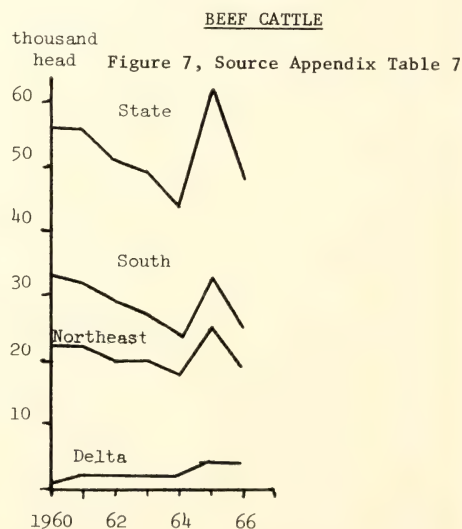
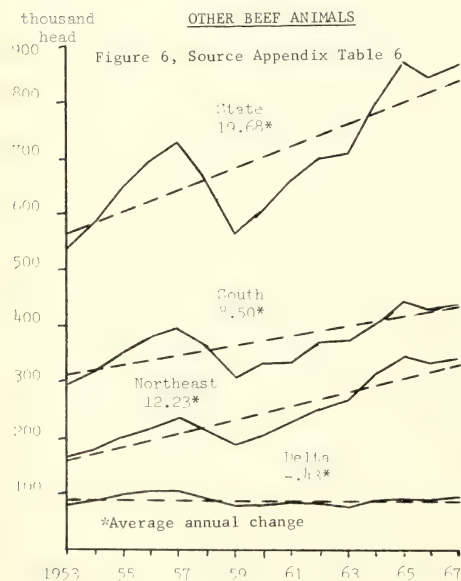
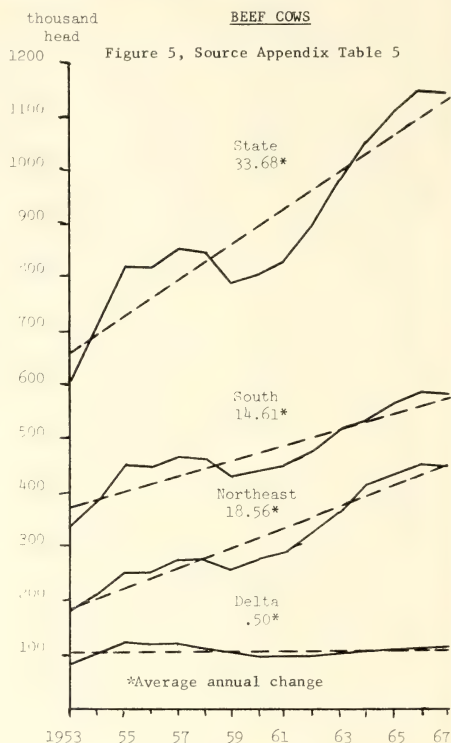


³Grade A cows were separated from other milk cows by point estimates of numbers during selected years. These estimates were obtained from Agricultural Experiment Station and Extension personnel and from other Departments of Agriculture.

Beef Cattle

Statistical reports class beef cattle as cows, beef animals fed or finished, and other beef cattle. Beef cows have been increasing at the rate of about 34 thousand head per year in Mississippi (Figure 5). About 14,600 head of this increase has been in the southern area and approximately 18,500 head in the northeastern area. Beef cow numbers have increased only slightly in the Delta. If these trends continue, the state will have approximately 1.4 million head of beef cows by 1975 (Table 1). Other beef animals have followed cow trends in the northeastern and southern areas but have declined slightly in the Delta (Figure 6).

Estimates of cattle on feed have been available for Mississippi for only six years.⁴ Since no meaningful projections could be made from these data, numbers in 1975 were assumed to be the same as the average for the 1960-66 period (Figure 7). Thus, the indicated number for 1975 is 52,000 head.



⁴Numbers placed on feed were actually available for 1964-66 only. The relationship between these numbers and the number on feed on January 1 in 1964-66 were used to estimate the number fed during other years when only January 1 numbers were reported.

Hogs

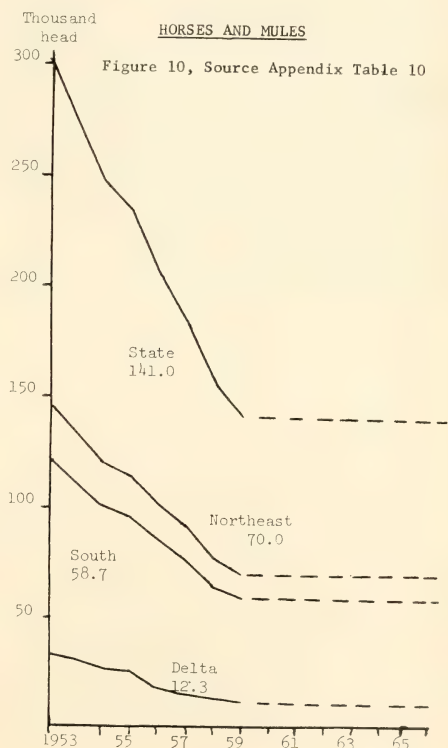
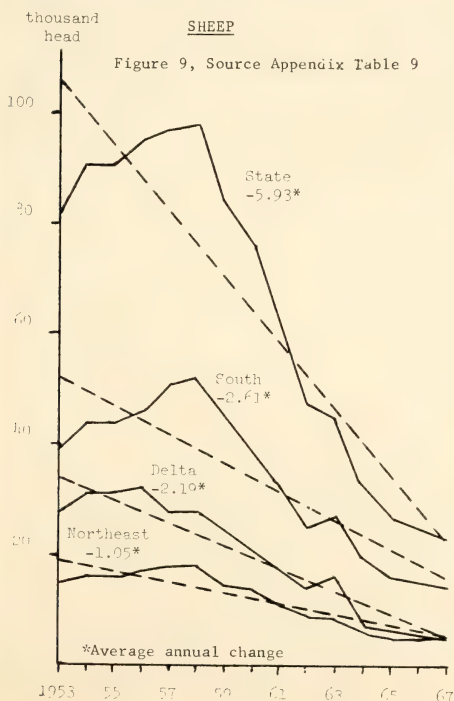
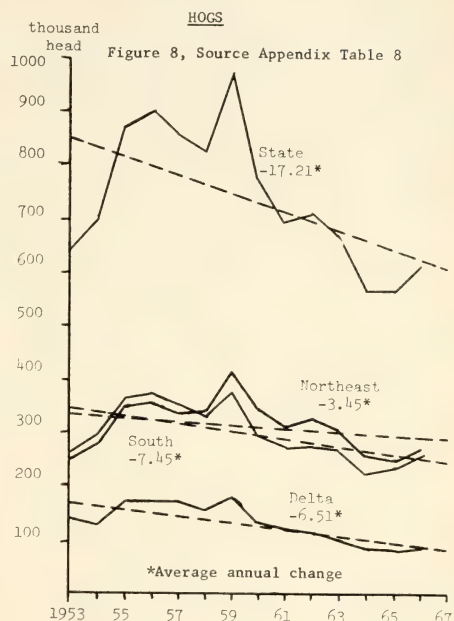
Hogs raised were estimated by adding spring and fall pig crops. Hog production has been declining in the state since 1959 (Figure 8). This trend has not been as evident in the northeastern area as it has in the South. Depending upon the hog cycle, an indicated 471 thousand head will be produced in 1975.

Sheep

Sheep numbers have been declining rapidly in Mississippi (Figure 9). Projection of the 1953-67 trends indicate sheep production will be out by 1975; however, it is probable a few flocks will remain.

Horses and Mules

The number of horses and mules declined from 302 thousand head in 1953 to only 141 thousand head in 1960, the year estimates were discontinued (Figure 10). Extension of this trend would place the 1975 number at zero. However, because of the increase in horses kept for pleasure, 1975 numbers were assumed to equal those of 1960.



Poultry

Four groups make up poultry: hens and pullets, chickens raised, commercial broilers, and turkeys raised.

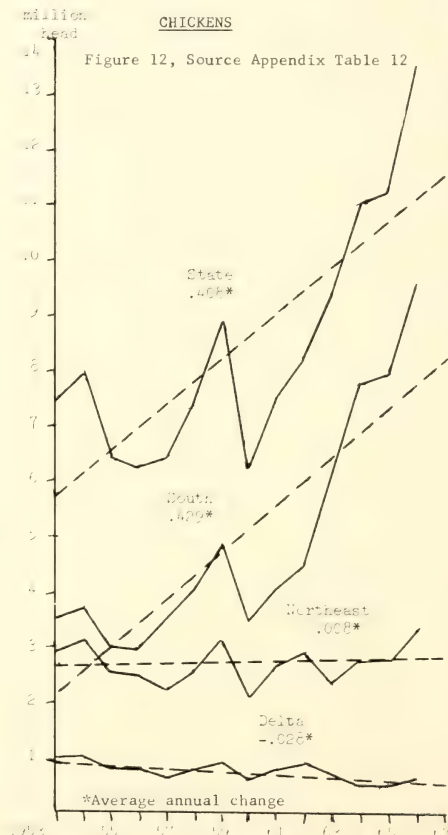
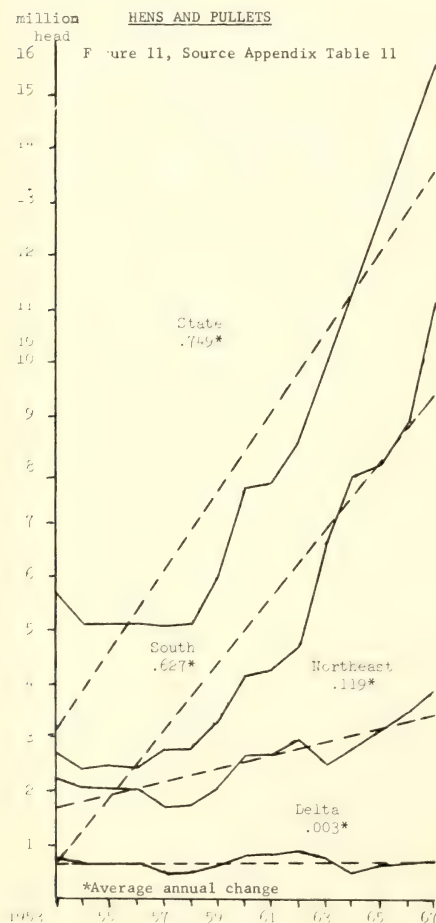
Since 1957-58 the number of hens and pullets has expanded rapidly in the southern area (Figure 11). If the 1953-67 trends continue, the state will have 19.6 million head by 1975 of which 14.5 million will be in the southern area (Table 1). However, if the acceleration in trend which began in the late 1950's continues, these projections will be low.

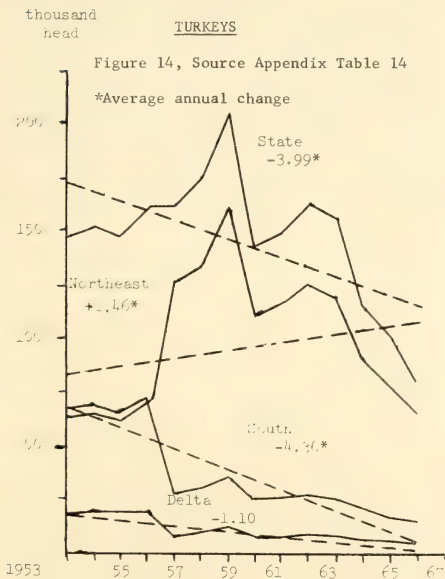
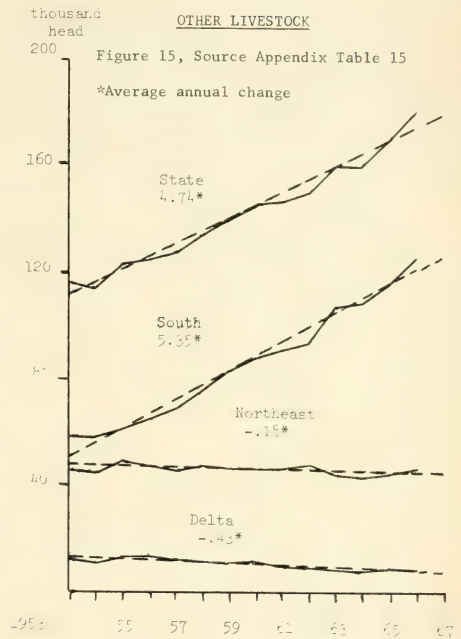
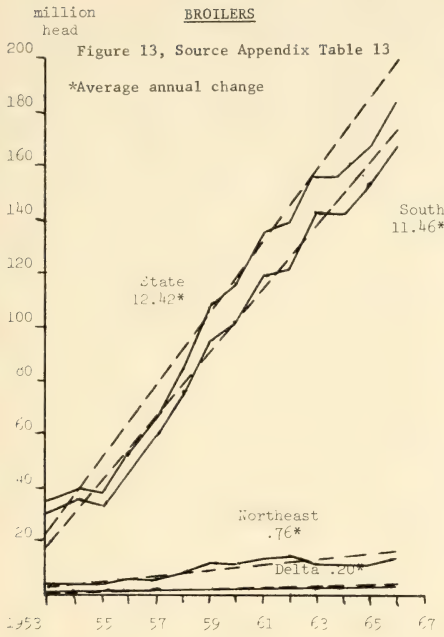
Although the number of chickens raised has generally increased, the changes have been highly irregular

(Figure 12). Fluctuations in production have been such that the 1975 projected numbers little more than exceed the 1964 numbers (Table 1).

Broiler production increased from 36 million birds in 1953 to 184 million in 1966 and was projected to 300 million in 1975 (Figure 13). Of this projected number, more than 272 million are expected to be in the southern area (Table 1).

Turkey production in the northeastern area and in the state has been quite erratic (Figure 14). A definite downward trend was present in the Delta and southern areas. However, the increase in the northeastern area is expected to more than offset this decline in these areas (Table 1).





Other Livestock

This miscellaneous group is made up of other livestock and poultry on farms not previously mentioned and all other livestock and poultry not on farms. The USDA estimates other livestock as five percent of all grain-consuming animal units.⁵ The data presented in Figure 15 may be viewed as indicating trends in grain consumption for all types of livestock and poultry in each substate area.

⁵A grain consuming animal unit is considered to consume the equivalent of the average United States milk cow.

TRENDS IN GRAIN PRODUCTION

Production trends for corn, grain sorghum, oats, wheat, and soybeans, the major feed grains used in Mississippi, are illustrated and discussed below.

Corn

As measured by grain-consuming animal units, Mississippi's feed grain requirements are increasing. Yet corn production in the state is rapidly declining (Figure 16). Production by 1975 was projected to be approximately 7 million bushels; however, if soybean production continues to increase, corn production may be well below this quantity (Table 2).

Grain Sorghum

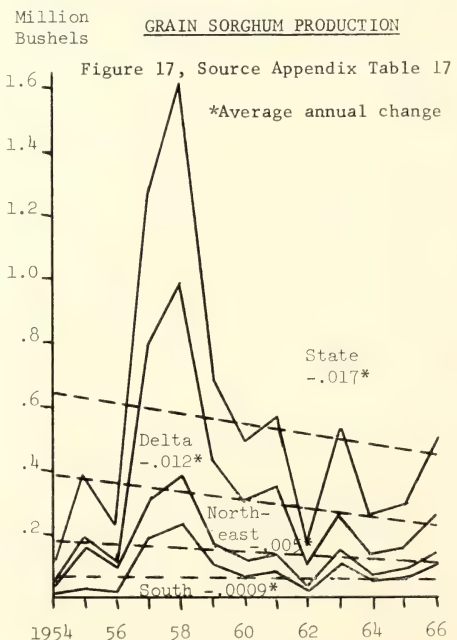
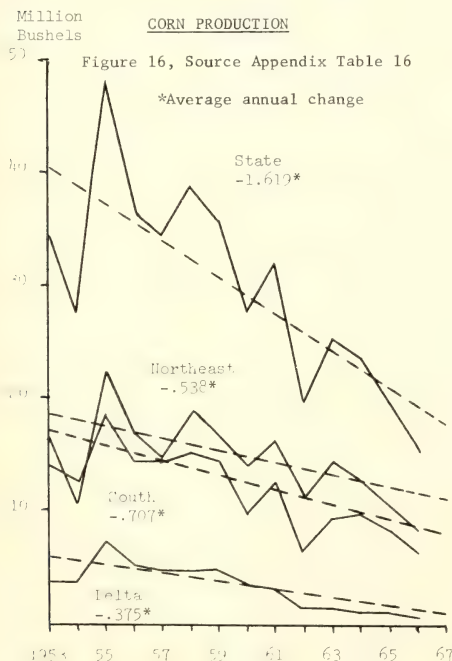
Production of grain sorghum has been rather erratic (Figure 17). Increasing yields in recent years have helped to offset declining acreages (Appendix Table 17).

Oats

Although the trend has not been very uniform, oat production appears to be going out in Mississippi (Figure 18). Projections indicate that oat production will be essentially nonexistent in the state by 1975 (Table 2).

Table 2. Grain production by substate areas of Mississippi, 1964 production and 1975 projections.

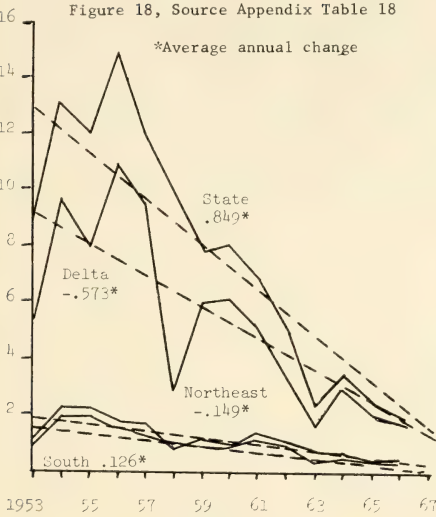
Crop	Delta (I)		Northeast (II)		South (III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
thousand bushels								
Corn	1,294	0	12,903	6,281	9,629	1,006	23,826	7,287
Grain sorghum	134	132	77	67	55	99	266	298
Oats	2,998	0	371	0	471	0	3,840	0
Wheat	3,844	6,098	311	833	50	95	4,205	7,026
Soybeans	19,504	44,514	4,525	10,816	538	1,526	24,567	56,856



Million
Bushels

OAT PRODUCTION

Figure 18, Source Appendix Table 18



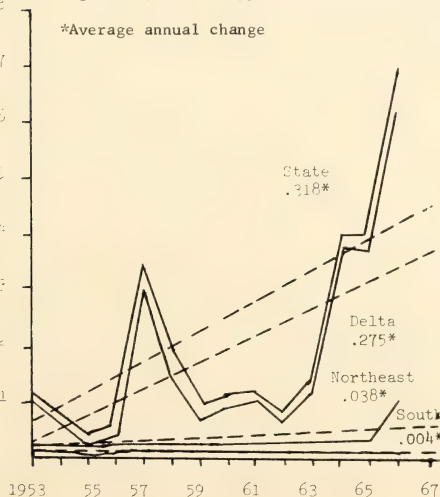
Wheat

Wheat has become a major crop in the Delta (Figure 19). If the trend, which began toward the latter part of the period included in the projection, continues, the projected quantity badly underestimates the 1975 production. For the entire 1953-66 period, it was difficult to fit a trend line which could be considered dependable.

Million
Bushels

WHEAT PRODUCTION

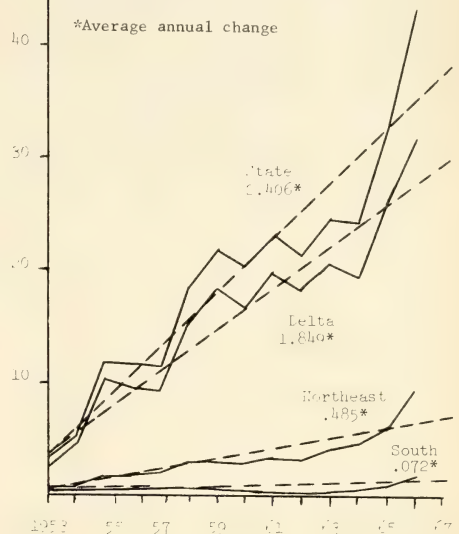
Figure 19, Source Appendix Table 19



Million
Bushels

SOYBEAN PRODUCTION

Figure 20, Source Appendix Table 20



Soybeans

Much land taken from cotton and corn production has been allocated to soybeans. Most soybeans have been produced in the Delta, and in accordance with trends, this area can be expected to continue to increase production at a rapid rate (Figure 20). Although the trend lines fit the data for the 1953-66 period quite well, 1965 and 1966 production moved well above the projection lines.

Unless a breakthrough results in a sizeable increase in yields, land in the Delta may be somewhat pushed to produce the projected 1975 level and continue at near the current level of acreages of other crops. However, there are no such limitations on the northeastern and southern areas. Depending upon government programs for soybeans and for other crops, the 1975 level of soybean production may greatly exceed the projected level of 56.9 million bushels.

UTILIZATION ESTIMATED BY GRAIN FLOWS

The flows of corn, grain sorghums, and oats, adjusted for production and changes in stocks, were used to estimate the respective quantities of each of these grains consumed in Mississippi during 1964. Details of these grain movements, which were classified by origin and destination and modes of transportation, were published separately.⁶

To avoid double counting of movements, local purchases and sales and intra-area movements were subtracted from total receipts and shipments, respectively, to estimate net flows for substate areas. Receipts for exports were excluded since these were not in shipments for the state but only movements directly through a state elevator.

Corn

Over 58 million bushels of corn were estimated to be available in Mississippi

during 1964 (Table 3). Of this quantity almost 34 million was shipped into the state compared with about 25 million bushels available from production in the state. During the year stocks increased over 600 thousand bushels. Approximately 65 percent of the available corn supply was in the southern area.

Grain Sorghum

Apparently grain sorghums are not very important in Mississippi's feed-grain economy neither from the viewpoint of production nor from that of feeding (Table 4). Less than one million bushels of grain sorghums were available for feeding in 1964. The Delta was the heaviest producing area but the southern area fed the most.

Oats

Until recently, Mississippi has produced more oats than were used in the

⁶W. A. Bell and T. D. Phillips, **Mississippi Grain Movements During 1964 with Comparisons with 1960**, Mississippi Agricultural Experiment Station AEC. M. R. No. 51, November 1966.

Table 3. Corn shipments and utilization estimates by substate areas of Mississippi, 1964.

Item	Delta (Area I)	Northeast (Area II)	South (Area III)	State
	thousand bushels			
Net inshipments	108	5,172	30,201	35,481
Net outshipments	0	0	1,557	1,557
Net flows	108	5,172	28,644	33,924
Production*	1,594	13,942	9,326	24,862
Net flows plus production	1,702	19,114	37,970	58,786
Increase in stocks**	41	362	242	645
Utilization	1,661	18,752	37,728	58,141

*Production includes 66.7% of 1963 production and 33.3% of 1964 production.

**Stocks were allocated to substate areas by applying each area's percentage of production to the total stock in Mississippi.

Table 4. Grain sorghum shipments and utilization by substate areas of Mississippi, 1964.

Item	Delta (Area I)	Northeast (Area II)	South (Area III)	State
	thousand bushels			
Net inshipments	72	0	432	504
Net outshipments	85	0	0	85*
Net flows	-13	0	432	419*
Production**	221	127	91	439
Net flows plus production	208	127	523	858
Utilization***	208	127	523	858

*Represents sum of substate areas; when duplication as a result of inter-area movements were removed, state outshipments were 17,000 bushels and net flows for the state were 487,000 bushels.

**Production includes 66.7% of 1963 production and 33.3% of 1964 production.

***Since stocks were not reported for January 1, 1964, stocks were assumed to remain unchanged.

state; however, in 1964 a net of more than one million bushels were shipped into the state (Table 5). An apparent 3.4 million bushels of oats were utilized

in the state. Most were produced in the Delta, but approximately two-thirds of those available were fed in the southern area.

Table 5. Oat shipments and utilization by substate areas of Mississippi, 1964.

Item	Delta (Area I)	Northeast (Area II)	South (Area III)	State
	thousand bushels			
Net inshipments	0	520	1,877	2,397*
Net outshipments	1,376	0	0	1,376*
Net flows	-1,376	520	1,877	1,021*
Production**	2,355	304	381	3,040
Net flows plus production	979	824	2,258	4,061
Increase in stocks***	517	67	83	667
Utilization	462	757	2,175	3,394

*Represents sum of substate areas; when duplication was removed because of inter-area movements, state inshipments were 1,511,000, state outshipments, 300,000 and net flows for the state were 1,211,000 bushels.

**Production includes half of 1963 production and half of 1964 production.

***Stocks were allocated to substate areas by applying each area's percentage of production to the total stock in Mississippi.

UTILIZATION ESTIMATED BY RATIONS

A second approach to estimating utilization was by multiplying animal numbers by their appropriate typical rations. The ration approach was necessary to project feed ingredient requirements for 1975.

Information for developing the rations was obtained from numerous sources; however, the final estimates were made by Agricultural Experiment Station and Extension Service personnel. After making preliminary comparisons between estimates from the flow and ration approaches, corn was substituted for grain sorghum and oats in the rations of some classes of animals.

Rations were developed for the same class of animals as was discussed previously except for dairy cows. The ration for dairy cows was developed to reflect the quantities fed both Grade A and other dairy cows.

Since swine numbers were on basis of numbers raised, the ration for this category was developed to fit the number raised per year adjusted to allow for breeding stock, postweaning losses, and wastes in feeding. Similar allowances were made in the case of turkeys.

The 1975 rations reflect the expected changes in efficiency, and adoption of feeding technology, and changes in weights of animals. Trends in feeding efficiency were used to develop these projected rations. Changes in the contents of rations reflect the substitution among feed ingredients expected to occur by 1975.

Rations were expected to apply to each animal in each substate area. Differences among areas in the availabilities of supplies of the various feed grains may have caused the ratio of grain in particular rations to differ among areas. Also, in some areas, more silage or hogging off of corn may have been used than in other areas.

Blanks in tables presenting utilization estimates do not necessarily indicate that none of the ingredient was fed in that particular category but that the amount was so small that it would not significantly affect the results. Also, in some cases, animal numbers were projected as approaching zero and, therefore, show up in the tables as none being fed at that time.⁷

The ration for other livestock represents the composition of feed fed this group on a national basis.

⁷Since rations are not included in this report, a check of the appropriate appendix table of animal numbers will indicate which of the above conditions existed when the indicated quantity was zero.

Corn

Corn utilization for 1964 estimated by the ration approach was nearly 56 million bushels (Table 6) compared with 58 million bushels by the flow approach (Table 3). This discrepancy was considered small since such uses as corn meal and industrial purposes were not considered. Also, the assumption was made that the net flows of feed containing corn were off-setting; however,

more corn may have been shipped out this way than was shipped in.

In 1964 poultry was the major consumer of corn; by 1975 this group is expected to consume an even larger proportion of the total estimated at 72.5 million bushels (Table 6). Commercial layers and broilers are each expected to consume more than 50 percent more corn in 1975 than was required in 1964.

Table 6. Consumption of corn by type of animals by substate areas of Mississippi, 1964 and projected for 1975.

Type of animal	Delta (Area I)		Northeast (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
	thousand bushels							
Milk cows	160	—	4,086	2,130	3,013	1,650	7,259	3,780
Other dairy animals	40	—	844	739	643	398	1,527	1,137
Beef cows	50	88	193	448	248	525	491	1,061
Other beef animals	266	429	1,013	2,324	1,309	2,709	2,588	5,462
Beef grain finished	93	86	527	902	745	1,246	1,365	2,234
Hogs raised	1,050	381	3,123	2,972	2,733	2,073	6,906	5,426
Sheep and lambs	8	—	7	—	24	—	39	—
Horses and mules	269	268	1,565	1,565	1,319	1,319	3,152	3,152
Hens and pullets	607	762	2,972	4,268	8,553	14,343	12,132	19,373
Chickens raised	162	99	792	757	2,279	3,108	3,233	3,964
Broilers	227	375	1,017	1,643	13,075	20,941	14,319	22,959
Turkeys	5	—	72	89	16	—	93	89
Other livestock	131	82	707	707	1,785	2,760	2,613	3,549
Total	3,067	2,570	16,918	18,544	35,732	51,072	55,717	72,186

Grain Sorghum

Even after making adjustments in the initial rations, estimates by this approach were considerably above those of the flow approach (Tables 4 and 7). Due to the relatively small number of grain firms handling grain sorghum, the flow estimate may not have been as accurate as for corn and oats. However, the flow estimate is probably more accurate than the ration estimate.

How close the nearly 6 million bushels by 1975 is met depends upon a num-

ber of factors. An earlier study indicated that during much of the 1959-60 period grain sorghum was a better buy for many animals.⁸ Yet very little difference was found in net quantities flowing into the state in 1960 and 1964. Grain sorghum has apparently not had wide feeder acceptance. Also, elevator operators and feeders probably do not have established contacts with suppliers of grain sorghum to the same extent they do with the suppliers of corn.

⁸T. B. Pugh and T. D. Phillips, **Efficiency of Mississippi Corn and Grain Sorghum Procurements, 1959-60**, Mississippi Agricultural Experiment Station, AEC. M. R. No. 39, July 1963.

Table 7. Consumption of sorghum grain by types of animals, by substate areas of Mississippi, 1964 and projected for 1975.

Type of animal	Delta (Area I)		Northeast (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
	thousand bushels							
Milk cows	2	—	58	95	74	103	169	—
Other dairy animals	—	—	7	30	5	16	46	—
Beef cows	—	—	—	—	—	—	—	—
Other beef animals	7	17	26	92	34	67	216	—
Beef grain finished	10	12	55	128	77	142	316	—
Hogs raised	47	68	141	534	123	373	975	—
Sheep and lambs	—	—	—	—	—	—	—	—
Horses and mules	—	—	—	—	—	—	—	—
Hens and pullets	46	128	225	718	648	2,412	919	3,258
Chickens raised	15	18	73	136	209	559	297	713
Broilers	—	—	—	—	—	—	—	—
Turkeys	—	—	6	16	1	—	7	16
Other livestock	9	6	48	48	120	186	177	240
Total	136	249	639	1,797	1,260	3,903	2,035	5,949

⁸Less than 500 bushels.

Oats

An estimated 3.6 million bushels of oats were fed in 1964 (Table 8). This quantity is in close agreement with the flow estimate of 3.4 million bushels available. Both oat production and utilization has been declining in the state in recent years. Projected oat consumption was kept in line with this trend despite increases in grain consuming animal units.

Other Feed Ingredients

Consumption of other concentrate feed ingredients are presented in Appendix Tables 21 through 27. In keeping with expected changes in the composition of livestock and poultry feed soybean meal consumption is expected to substantially increase by 1975 while cottonseed meal declines (Appendix Tables 21 and 22).

Table 8. Consumption of oats by types of animal, by substate areas of Mississippi, 1964 and projected for 1975.

Type of animal	Delta (Area I)		Northeast (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
thousand bushels								
Milk cows	19	—	486	133	358	103	863	236
Other dairy animals	7	—	157	78	119	42	283	120
Beef cows	9	9	32	46	42	54	83	109
Other beef animals	36	34	138	182	178	213	352	429
Beef grain finished	—	—	—	—	—	—	—	—
Hogs raised	3	1	8	8	6	6	17	15
Sheep and lambs	—	—	—	—	1	—	1	—
Horses and mules	38	38	219	219	184	184	441	441
Hens and pullets	33	46	162	256	467	861	662	1,163
Chickens raised	5	3	25	26	73	109	103	138
Broilers	—	—	—	—	—	—	—	—
Turkeys	—	—	6	8	1	—	7	8
Other livestock	40	25	218	213	546	852	804	1,090
Total	190	156	1,451	1,169	1,975	2,424	3,616	3,749

*Less than 500 bushels.

PROJECTED BALANCES OF GRAINS

Major adjustments will be needed to handle the volumes of grains being produced and fed in Mississippi in 1975. For example, in 1964 utilization of corn exceeded production by at least 31.9 million bushels (Tables 2 and 6). Actual net inflows were considerably higher as explained previously (Table 3). By 1975, this difference is expected to approximately double (Table 9). The change in the magnitude of requirements from out-of-state sources does not in itself tell the complete story. Relatively, the northeastern area will be gaining in corn production (although losing in absolute quantity) while the southern area gains in utilization. This indicates that a smaller proportion of the grains used in 1975 will be grown on farms where they are fed. Thus, more marketing facilities will be required because of relative increases in movements.

Although less than one-third of the soybeans expected to be produced in Mississippi will be required for soybean

meal for feeding, the magnitude of movements of soybeans and soybean meal may be larger than indicated by these data (Table 9). Depending upon crushing margins and export rates, most soybeans may be exported some years, as in 1964, and soybean meal purchased from out-of-state sources.

If the projected grain sorghum requirements are met, large inshipments will likely be required. On the other hand, wheat will be shipped from the state for export and to flour mills. Most oats will also be required from out-of-state sources.

Rather rapid adjustments were made in storage capacities of grain firms in the state during the period 1960 to 1964 (Table 10). Two million of the bushels added in the South were for the export elevator at Pascagoula. Adjustments have been made in marketing facilities since January 1, 1964 and others are underway or being planned. Still more will be needed as production and utilization change.

Table 9. Projected grain production, utilization, and balances by substate areas of Mississippi for 1975.

Grain	Delta (Area I)				Northeast (Area II)				South (Area III)				State	
	Pro- duction	Util- ization	Dif- ference*	Pro- duction	Util- ization	Dif- ference*	Pro- duction	Util- ization	Dif- ference*	Pro- duction	Util- ization	Dif- ference*	Util- ization	Dif- ference*
Corn	0	2,570	-2,570	6,281	18,544	-12,263	1,006	51,072	-50,066	7,287	72,186	-64,899		
Soybeans	44,515	458 ^{0.0}	44,057	10,816	3,292**	7,524	1,526	12,875	-11,349	56,857	16,625	40,232		
Grain sorghum	132	249	-117	67	1,797	-1,730	99	3,903	-3,804	298	5,949	-5,651		
Wheat	6,098	1	6,097	833	12	821	95	48	47	7,026	61	6,965		
Oats	0	156	-156	0	1,169	-1,169	0	2,424	-2,424	0	3,749	-3,749		
Total	50,745	3,434	47,311	17,997	24,814	-6,817	2,726	70,322	-67,596	71,468	98,570	-27,102		

*Negative signs represent deficit production.

**Soybeans needed for soybean meal consumption, based on obtaining 48 pounds of meal per bushel of soybeans.

Table 10. Total bulk and sack storage capacities of grain handling facilities, by primary type of business, by area, Mississippi, January 1, 1960 and 1964.

Type of business, by area, Mississippi, January 1, 1960 and 1964				
Type of business and year	Area			State
	Delta	Northeast	South	
1960	thousand bushels			
Feed mill				
Bulk		843	865	1,708
Sack		268	619	877
Total		1,111	1,484	2,595
Oil mill**				
Bulk	6,015	335	1,925	8,275
Sack	0	0	0	0
Total	6,015	335	1,925	8,275
Elevator				
Bulk	8,198	629	952	9,770
Sack	359	76	0	435
Total	8,458	705	952	10,205
Grand Total 1960	14,563	2 151	4,361	21,075
1964				
Feed mill				
Bulk	388	962	1,688	3,038
Sack	50	102	321	473
Total	438	1,064	2,009	3,511
Oil mill				
Bulk	6,457	291	1,267	8,015
Sack	0	0	0	0
Total	6,457	291	1,267	8,015
Elevator				
Bulk	14,826	605	4,300	19,731
Sack	137	0	0	137
Total	14,963	605	4,300	19,868
Grand Total 1964	21,858	1,960	7,576	31,394

*One large feed mill in the area was also involved in elevator operations, and because of this, it was included in the elevator group. The expanded storage capacity of the one firm sampled indicated less than 1,000 bushels of storage capacity in the district in total.

**Includes only those mills processing soybeans in either 1959 or 1960.

Source: W. A. Bell and T. D. Phillips, **Mississippi Grain Movements During 1964 With Comparisons With 1960**, Mississippi Agricultural Experiment Station, AEc. M. R. No. 51, November 1966.

APPENDIX

Appendix Table 1. Milk cows, 2 years and over, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	42	294	240	576
1954	42	301	250	593
1955	41	297	249	587
1956	37	299	245	581
1957	31	285	230	546
1958	24	270	214	508
1959	19	246	192	457
1960	14	232	179	425
1961	12	223	169	404
1962	10	208	158	376
1963	9	209	132	350
1964	7	192	119	318
1965	6	181	112	299
1966	5	171	108	284
1967	6	157	98	261

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service. Allocation of 1967 total was made using 1966 percentages.

Appendix Table 2. Grade A milk cows, 2 years and over, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	6	52	95	153
1954	6	52	94	152
1955	5	52	93	150
1956	5	52	91	148
1957	4	52	91	147
1958	4	52	88	144
1959	3	52	86	141
1960	2	53	84	139
1961	2	52	82	136
1962	2	53	80	135
1963	1	53	79	133
1964	1	52	77	130
1965	1	50	75	126
1966	1	49	72	122
1967	1	45	66	112
1975	0	47	55	102

Source: Grade A milk cows were separated from other milk cows by selecting point estimates for given years obtained from Agricultural Experiment Station and Extension personnel. State totals were allocated to districts on basis of number of herds by counties from USDA Crop and Livestock Reporting Service.

Appendix Table 3. Other milk cows, 2 years and over, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	37	241	145	423
1954	37	248	156	441
1955	36	245	156	437
1956	32	247	154	433
1957	26	233	140	399
1958	21	217	126	364
1959	16	194	106	316
1960	12	180	94	286
1961	11	172	85	268
1962	8	155	78	241
1963	8	156	53	217
1964	6	140	42	188
1965	5	131	37	173
1966	4	122	36	162
1967	5	112	32	149
1975	0	24	0	24

Source: Numbers were determined by subtracting Grade A cows from all milk cows on both the state and district levels.

Appendix Table 4. All other dairy animals, Mississippi, by substate areas.*

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	23	160	132	315
1954	23	163	136	322
1955	22	156	130	308
1956	19	149	122	290
1957	16	146	117	279
1958	13	142	113	268
1959	11	137	107	255
1960	8	140	108	256
1961	7	138	105	250
1962	6	130	99	235
1963	6	117	89	212
1964	5	105	80	190
1965	4	100	76	180
1966	5	97	74	176
1967	4	87	66	157
1975	0	52	28	80

Source: State totals and substate totals were obtained from USDA Crop and Livestock Reporting Service.

*Bulls were allocated proportionately between dairy and beef cows. Dairy bulls were then allocated to substate areas in proportion to dairy cows.

Appendix Table 5. Beef cows, 2 years and over, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	84	185	332	601
1954	104	218	390	712
1955	122	254	445	821
1956	120	255	445	820
1957	120	273	465	858
1958	113	274	462	849
1959	101	257	429	787
1960	99	271	438	808
1961	100	284	448	832
1962	100	321	478	899
1963	102	362	516	980
1964	109	414	534	1,057
1965	113	433	565	1,111
1966	115	453	587	1,155
1967	119	452	582	1,153
1975	116	592	693	1,401

Source: State totals are January 1 number of other cows from USDA Crop and Livestock Reporting Service. Agricultural Census data used to allocate totals to the districts through 1964. Data for 1965-67 allocated by Crop and Livestock Reporting Service reports of county data.

Appendix Table 6. All other beef animals, Mississippi, by substate areas.*

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	75	166	298	539
1954	86	180	321	587
1955	97	202	354	653
1956	103	218	381	702
1957	102	234	398	734
1958	89	217	365	671
1959	73	185	309	567
1960	76	207	335	618
1961	80	226	357	663
1962	78	251	374	703
1963	74	264	377	715
1964	83	315	407	805
1965	89	341	445	875
1966	85	333	432	850
1967	90	341	442	873
1975	79	429	500	1,008

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service. Agricultural Census was used to allocate state totals into counties for years prior to 1965. The 1965-67 allocation is the same as for beef cows.

*Bulls allocated to beef animals were divided among substate areas in proportion to beef cattle.

Appendix Table 7. Beef cattle fed, Mississippi, by substate areas.* **

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1960	1	22	33	56
1961	2	22	32	56
1962	2	20	29	51
1963	2	20	27	49
1964	2	18	24	44
1965	4	25	33	62
1966	4	19	25	48
1975	2	21	29	52

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service. Agriculture Census was used to break state totals into districts.

*Number of animals fed during the year is the quarterly sum of animals placed on feed during the year. For all years prior to 1964, the average relationship between 1964-66 numbers and the number of animals on feed on January 1 of these years was used to estimate the total number fed.

**The 1975 estimates are the averages of all numbers for district and state levels.

Appendix Table 8. Hogs raised, Mississippi, by substate areas.*

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	141	252	260	653
1954	133	277	292	702
1955	173	344	360	877
1956	176	356	370	902
1957	172	336	352	860
1958	159	337	329	825
1959	181	416	376	973
1960	138	342	290	770
1961	121	310	265	696
1962	117	325	270	712
1963	105	300	262	667
1964	86	256	224	566
1965	82	245	234	561
1966	88	267	259	614
1975	33	258	180	471

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service.

*Sum of Spring and Fall pigs saved allocated on basis of January 1 numbers.

Appendix Table 9. Sheep, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	28	15	40	83
1954	31	16	44	91
1955	31	16	44	91
1956	32	17	46	95
1957	28	18	51	97
1958	28	18	52	98
1959	24	15	45	84
1960	21	14	39	74
1961	18	11	33	62
1962	14	9	25	48
1963	10	8	27	45
1964	7	6	20	33
1965	6	5	16	27
1966	5	5	15	25
1967	5	4	14	23
1975	0	0	0	0

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service. Agriculture Census was used to allocate the state totals into districts. 1954 data was used for 1953-56; 1959 data for 1957-62; and 1964 data for 1963-67.

Appendix Table 10. Horses and mules, 2 years and older, Mississippi, by substate areas.*

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	33	146	123	302
1954	30	133	112	275
1955	27	120	100	247
1956	26	113	95	234
1957	18	102	85	205
1958	16	90	76	182
1959	14	77	64	155
1960	12	70	59	141
1975	12	70	59	141

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service. Agricultural Census was used to break the state totals into counties. The 1954 data was used for 1953-56 and the 1959 data for 1957-60.

*Number of horses and mules assumed to remain unchanged.

Appendix Table 11. Hens and pullets, January 1, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	774	2,254	2,669	5,697
1954	704	2,052	2,429	5,185
1955	705	2,053	2,430	5,188
1956	700	2,038	2,413	5,151
1957	557	1,759	2,758	5,074
1958	560	1,768	2,773	5,101
1959	661	2,087	3,272	6,020
1960	843	2,664	4,177	7,684
1961	851	2,688	4,216	7,755
1962	942	2,978	4,669	8,589
1963	807	2,511	6,645	9,963
1964	558	2,732	7,863	11,153
1965	641	3,137	9,030	12,808
1966	702	3,440	9,899	14,041
1967	792	3,880	11,169	15,841
1975	770	4,314	14,498	19,582

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service. Agricultural Census was used to break the state total into counties.

Appendix Table 12. Chickens raised—replacement—percentage of hens and pullets, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
thousand head				
1953	1,017	2,961	3,504	7,482
1954	1,078	3,138	3,715	7,931
1955	873	2,542	3,009	6,424
1956	856	2,491	2,949	6,296
1957	704	2,227	3,491	6,422
1958	817	2,583	4,050	7,450
1959	981	3,100	4,859	8,940
1960	686	2,170	3,402	6,258
1961	824	2,604	4,082	7,510
1962	906	2,864	4,491	8,261
1963	763	2,373	6,282	9,418
1964	551	2,700	7,768	11,019
1965	564	2,766	7,961	11,291
1966	677	3,320	9,552	13,549
1975	368	2,822	11,583	14,773

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service. State totals allocated to districts by Agricultural Census data.

Appendix Table 13. Broilers raised, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
	thousand head			
1953	500	4,109	31,062	35,671
1954	564	4,644	35,100	40,308
1955	525	4,318	32,643	37,486
1956	740	6,089	46,026	52,855
1957	1,112	6,860	58,625	66,597
1958	1,426	8,799	75,199	85,424
1959	1,797	11,086	94,746	107,629
1960	1,935	11,938	102,027	115,900
1961	2,268	13,986	119,537	135,791
1962	2,332	14,379	112,894	139,605
1963	2,474	11,120	142,916	156,510
1964	2,481	11,151	143,306	156,938
1965	2,654	11,927	153,286	167,867
1966	2,939	13,046	167,749	183,734
1975	4,871	21,354	272,231	298,456

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service. Agricultural Census for number of broilers sold was used to allocate state totals into districts with 1954 data used for 1953-56, 1959 data for 1957-62, and 1964 estimates for 1963-66.

Appendix Table 14. Turkeys raised, heavy and light combined, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
	thousand head			
1953	18	64	66	148
1954	19	65	68	152
1955	18	63	66	147
1956	19	70	73	162
1957	9	126	28	163
1958	10	135	30	175
1959	11	161	36	208
1960	8	111	25	144
1961	8	116	26	150
1962	9	126	28	163
1963	9	120	27	156
1964	6	90	20	116
1965	6	79	17	102
1966	5	66	15	86
1975	9	122	0	122

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service. Agricultural Census used to allocate state totals into districts. The 1954 data was used for 1953-56, 1959 for 1957-62 and 1964 estimates for 1963-66.

Appendix Table 15. Other livestock*, Mississippi, by substate areas.

Year	Delta (I)	Northeast (II)	South (III)	State
	thousand head			
1953	13	46	57	116
1954	12	45	57	114
1955	14	49	60	123
1956	14	47	64	125
1957	13	46	68	127
1958	12	47	75	134
1959	11	46	83	140
1960	12	46	87	145
1961	10	46	90	146
1962	10	47	93	150
1963	9	44	106	159
1964	8	43	108	159
1965	9	44	116	169
1966	9	46	125	180
1975	5	43	168	216

Source: Correspondence with George C. Allen, Farm Production Economics Division, ERS, USDA, Washington, D. C., March 1, 1966.

*Other livestock and poultry on farms and all other livestock and poultry not on farms.

Appendix Table 16. Corn for grain, Mississippi, harvested acreage, yield, and production by substate areas.

Year	Acreage				Yield				Production			
	Delta (I)	NE (II)	South (III)	State	Delta (I)	NE (II)	South (III)	State	Delta (I)	NE (II)	South (III)	State
	thousand acres				bushels				thousand bushels			
1953	172	755	643	1,570	22.4	21.8	22.0	22.0	3,859	16,532	14,150	34,541
1954	218	790	656	1,664	17.4	13.8	19.3	16.5	3,809	10,931	12,719	27,459
1955	199	774	641	1,614	36.7	29.1	23.9	30.0	7,316	22,569	18,536	48,421
1956	169	727	570	1,466	30.3	23.2	25.6	25.0	5,123	16,888	14,615	36,626
1957	156	670	558	1,384	31.7	22.3	26.0	25.0	4,955	14,987	14,559	34,501
1958	147	623	505	1,275	32.8	26.7	30.4	30.5	4,826	16,648	15,352	38,826
1959	132	572	454	1,158	37.8	28.5	32.2	31.0	4,986	16,314	14,598	35,898
1960	108	515	408	1,031	33.1	27.8	24.4	27.0	3,573	14,298	9,966	27,837
1961	76	418	331	825	41.4	38.8	34.6	39.0	3,150	16,238	12,787	32,171
1962	58	381	295	734	30.7	29.0	23.6	27.0	1,782	11,062	6,974	19,818
1963	50	369	286	705	34.9	39.2	32.1	36.0	1,744	14,461	9,175	25,380
1964	38	335	254	627	34.1	38.5	37.9	38.0	1,294	12,903	9,629	23,826
1965	28	274	206	508	36.4	37.5	38.9	38.0	1,019	10,266	8,019	19,304
1966	23	241	183	447	34.4	35.3	34.7	35.0	792	8,498	6,355	15,645

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service.

Appendix Table 17. Sorghum for grain, Mississippi, harvested acreage, yield, and production by substate areas.*

Year	Acreage				Yield				Production			
	Delta (I)	NE (II)	South (III)	State	Delta (I)	NE (II)	South (III)	State	Delta (I)	NE (II)	South (III)	State
	thousand acres				bushels				thousand bushels			
1953 ^{a,b}												
1954	3	2	1	6	13.6	17.5	8.0	14.0	41	35	8	84
1955	10	8	2	20	18.5	20.0	17.5	19.0	185	160	35	380
1956	6	6	1	13	19.0	16.3	22.0	18.0	114	98	22	234
1957	27	10	6	43	29.3	30.8	31.6	30.0	792	308	190	1,290
1958	33	13	3	54	30.1	29.7	29.7	30.0	995	387	238	1,620
1959	13	5	3	21	32.8	33.0	34.0	33.0	426	165	102	693
1960	9	3	2	14	33.4	39.0	36.0	35.0	301	117	72	490
1961	10	4	2	16	34.4	33.5	41.0	35.0	344	134	82	560
1962	4	1	1	6	25.8	40.0	25.0	28.0	103	40	25	168
1963	7	4	4	15	37.7	38.0	27.2	35.0	264	132	109	525
1964	3	2	2	7	44.7	38.5	27.5	38.0	134	77	55	266
1965	5	2	2	9	30.0	43.0	30.5	33.0	150	86	61	297
1966	6	3	3	12	43.3	49.7	35.7	43.0	260	149	107	516

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service.

^aCensus of Agriculture data on quantities harvested were used to allocate state totals. The 1954 census was used for 1954-55, the 1959 census was used for 1957-62, and the 1964 census was used for 1963-66.^bData not reported.

Appendix Table 18. Oats for grain, Mississippi harvested acreage, yield, and production by substate areas.

Year	Acreage				Yield				Production			
	Delta (I)	NE (II)	South (III)	State	Delta (I)	NE (II)	South (III)	State	Delta (I)	NE (II)	South (III)	State
				thousand acres				bushels				thousand bushels
1953	133	41	44	218	41.9	39.8	34.4	40.0	5,572	1,633	1,515	8,720
1954	227	61	61	349	43.4	35.7	31.8	40.0	9,842	2,180	1,939	13,961
1955	272	65	64	401	29.5	31.6	30.4	30.0	8,033	2,054	1,943	12,030
1956	233	54	53	341	50.1	34.8	33.4	45.0	11,685	1,877	1,806	15,368
1957	248	40	39	341	38.9	40.7	25.6	37.0	9,635	1,627	1,355	12,617
1958	82	25	26	133	34.4	29.6	31.8	33.0	2,825	738	826	4,389
1959	138	30	32	200	43.2	36.2	29.9	40.0	5,957	1,086	957	8,000
1960	112	24	24	160	53.4	38.3	35.4	50.0	6,138	977	865	8,000
1961	109	26	30	165	47.1	41.6	39.4	45.0	5,162	1,088	1,175	7,425
1962	76	22	24	121	44.3	35.9	37.3	42.0	3,424	832	868	5,124
1963	52	8	10	70	33.0	30.4	28.8	32.0	1,712	237	291	2,240
1964	60	9	11	80	48.6	41.5	40.6	48.0	2,998	371	471	3,840
1965	49	7	9	65	42.7	32.7	32.5	42.0	2,183	240	307	2,730
1966	46	6	8	60	37.9	34.7	45.4	37.0	2,680	338	402	3,420

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service.

Appendix Table 19. Wheat for grain, Mississippi, harvested acreage, yield, and production by substate areas.

Year	Acreage				Yield				Production			
	Delta (I)	NE (II)	South (III)	State	Delta (I)	NE (II)	South (III)	State	Delta (I)	NE (II)	South (III)	State
				thousand acres				bushels				thousand bushels
1953 ^a	39	5	1	45	26.7	25.2	30.0	26.5	1,036	126	30	1,192
1954 ^a	24	3	1	28	28.4	27.7	20.0	28.0	681	83	20	784
1955 ^a	11	2	0	13	22.6	15.0	—	22.0	249	30	7	286
1956 ^a	15	2	1	18	29.2	26.5	13.0	28.0	438	53	13	504
1957	142	18	1	161	21.6	21.1	24.0	21.5	3,080	380	24	3,484
1958	95	15	2	112	16.7	19.2	13.5	17.0	1,588	289	27	1,904
1959	28	4	1	33	26.0	19.2	17.0	25.5	728	90	24	842
1960	31	5	1	37	31.8	25.8	17.0	30.5	985	126	17	1,128
1961	36	5	1	42	28.6	25.2	17.0	28.0	1,030	129	17	1,176
1962	26	4	0	30	25.7	29.2	—	26.0	669	102	9	780
1963	35	6	1	42	31.8	29.2	15.0	31.0	1,112	175	15	1,302
1964	132	11	2	145	29.1	25.0	25.0	29.0	3,844	311	50	4,205
1965	136	15	2	153	27.7	25.5	27.0	27.5	3,772	382	54	4,208
1966	181	35	4	220	34.6	31.2	31.0	34.0	6,265	1,091	124	7,480

Source: State totals and where possible substate totals were obtained from USDA Crop and Livestock Reporting Service.

^aCensus of Agriculture data on quantities harvested were used to all state totals.^aLess than 500 acres.

Appendix Table 21. Consumption of soybean meal by type of animal, by substate areas of Mississippi, 1964 and projected for 1975.

Type of animal	Delta (Area I)		NE (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
	thousand tons							
Milk cows	1	—	19	11	14	8	34	19
Other dairy animals	°	—	3	2	2	1	5	3
Beef cows	—	1	—	6	—	7	—	14
Other beef animals	°	1	°	4	°	4	—	9
Beef grain finished	—	—	—	—	—	—	—	—
Hogs raised	5	2	16	15	14	10	35	27
Sheep and lambs	°	—	°	—	°	—	—	—
Horses and mules	—	—	—	—	—	—	—	—
Hens and pullets	2	4	9	20	25	67	36	91
Chickens raised	1	°	4	4	10	15	15	19
Broilers	2	3	9	15	115	191	126	209
Turkeys	—	—	°	1	°	—	—	1
Other livestock	1	°	1	1	4	6	6	7
Total	12	11	61	79	184	309	257	399

°Less than 500 tons.

Appendix Table 22. Consumption of cotton seed meal by type of animal, by substate areas of Mississippi, 1964 and projected for 1975.

Type of animal	Delta (Area I)		NE (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
	thousand tons							
Milk cows	1	—	31	11	23	8	55	19
Other dairy animals	°	—	4	2	3	1	7	3
Beef cows	5	6	21	32	27	37	53	75
Other beef animals	2	2	8	8	11	10	21	20
Beef grain finished	°	°	3	2	4	3	7	5
Hogs raised	2	°	3	2	2	2	7	4
Sheep and lambs	°	—	°	—	°	—	°	—
Horses and mules	—	—	—	—	—	—	—	—
Hens and pullets	—	—	—	—	—	—	—	—
Chickens raised	—	—	—	—	—	—	—	—
Broilers	—	—	—	—	—	—	—	—
Turkeys	—	—	—	—	—	—	—	—
Other livestock	°	°	1	1	2	3	3	4
Total	10	8	71	58	72	64	153	130

°Less than 500 tons.

Appendix Table 23. Consumption of other oilseed meal by type of animal, by substate areas of Mississippi, 1964 and projected for 1975.*

Type of animal	Delta (Area I)		NE (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
	thousand tons							
Milk cows	°*	—	1	—	1	—	2	—
Other dairy animals	0	—	0	—	0	—	0	—
Beef cows	—	—	—	—	—	—	—	—
Other beef animals	—	—	—	—	—	—	—	—
Beef grain finished	—	—	—	—	—	—	—	—
Hogs raised	—	—	—	—	—	—	—	—
Sheep and lambs	—	—	—	—	—	—	—	—
Horses and mules	—	—	—	—	—	—	—	—
Hens and pullets	—	—	—	—	—	—	—	—
Chickens raised	—	—	—	—	—	—	—	—
Broilers	—	—	—	—	—	—	—	—
Turkeys	—	—	—	—	—	—	—	—
Other livestock	0	0	0	0	0	0	0	—
Total	0	0	1	0	1	0	2	0

°Includes linseed meal, peanut meal, and copra meal.

°*Less than 500 tons.

Appendix Table 24. Consumption of animal protein by type of animal, by substate areas of Mississippi, 1964 and projected for 1975.*

Type of animal	Delta (Area I)		NE (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
thousand tons								
Milk cows	**	—	—	—	—	—	**	—
Other dairy animals	—	—	0	0	0	0	—	0
Beef cows	—	—	—	—	—	—	—	—
Other beef animals	—	—	—	—	—	—	—	—
Beef grain finished	—	—	—	—	—	—	—	—
Hogs raised	1	0	4	4	3	3	8	7
Sheep and lambs	—	—	—	—	—	—	—	—
Horses and mules	—	—	—	—	—	—	—	—
Hens and pullets	1	2	5	9	15	30	21	41
Chickens raised	0	0	1	1	4	6	5	7
Broilers	1	1	3	4	36	54	40	59
Turkeys	0	—	0	0	0	—	0	—
Other livestock	0	0	0	0	1	2	1	2
Total	3	3	13	18	59	95	75	116

*Includes tankage, meat scraps, fish meal, and dried milk products.

**Less than 500 tons.

Appendix Table 25. Consumption of grain protein by type of animal, by substate areas of Mississippi, 1964 and projected for 1975.*

Type of animal	Delta (Area I)		NE (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
thousand tons								
Milk cows	**	—	4	3	3	2	7	5
Other dairy animals	0	—	0	1	0	0	0	1
Beef cows	—	—	—	—	—	—	—	—
Other beef animals	0	0	1	1	1	1	2	2
Beef grain finished	—	—	—	—	—	—	—	—
Hogs raised	—	—	—	—	—	—	—	—
Sheep and lambs	—	—	—	—	—	—	—	—
Horses and mules	—	—	—	—	—	—	—	—
Hens and pullets	0	1	2	3	6	12	8	16
Chickens raised	—	0	—	—	—	—	—	—
Broilers	0	0	1	2	7	27	8	29
Turkeys	—	—	—	—	—	—	—	—
Other livestock	0	0	0	0	1	1	1	1
Total	—	1	8	10	18	43	26	54

*Includes gluten feed and meal, brewer's dried grains, and distillers dried grains.

**Less than 500 tons.

Appendix Table 26. Consumption of mill feed by type of animal, by substate areas of Mississippi, 1964 and projected for 1975.*

Type of animal	Delta (Area I)		NE (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
thousand tons								
Milk cows	**	—	7	5	5	4	12	9
Other dairy animals	0	—	1	1	1	0	2	1
Beef cows	0	0	1	2	1	2	2	4
Other beef animals	0	0	0	0	0	0	0	0
Beef grain finished	—	—	—	—	—	—	—	—
Hogs raised	—	—	—	—	—	—	—	—
Sheep and lambs	—	—	—	—	—	—	—	—
Horses and mules	0	0	1	1	1	1	2	2
Hens and pullets	3	3	13	14	37	47	53	64
Chickens raised	1	0	3	3	8	12	12	15
Broilers	—	—	—	—	—	—	—	—
Turkeys	0	—	0	0	0	—	0	0
Other livestock	1	0	4	4	9	14	14	18
Total	5	3	30	30	62	80	97	113

*Includes wheat and rice mill feeds.

**Less than 500 tons.

Appendix Table 27. Consumption of other by-product feeds by type of animal, by substate areas of Mississippi, 1964 and projected for 1975.*

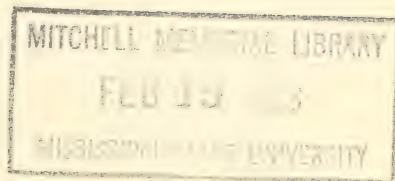
Type of animal	Delta (Area I)		NE (Area II)		South (Area III)		State	
	1964	1975	1964	1975	1964	1975	1964	1975
thousand tons								
Milk cows	1	—	15	13	11	10	27	23
Other dairy animals	**	—	1	1	1	0	2	1
Beef cows	1	1	2	5	3	6	6	12
Other beef animals	1	1	2	3	3	3	6	7
Beef grain finished	**	0	1	2	1	2	2	4
Hogs raised	1	0	4	4	3	3	8	7
Sheep and lambs	—	—	—	—	—	—	—	—
Horses and mules	**	0	2	2	1	1	3	3
Hens and pullets	1	2	5	11	17	36	23	49
Chickens raised	**	0	2	2	5	7	7	9
Broilers	1	1	3	5	43	68	47	74
Turkeys	**	—	**	0	**	—	**	0
Other livestock	1	0	4	4	10	15	15	19
Total	7	5	41	52	98	151	146	208

*Includes dried and molasses beet pulp, alfalfa meal, molasses, hominy, oat mill feed, screenings, add fats, vitamins and minerals.

**Less than 500 tons.

COST OF PROCESSING AND DISTRIBUTING GRADE "A" MILK IN MISSISSIPPI

by
Verner G. Hurt



**MISSISSIPPI STATE UNIVERSITY
MISSISSIPPI AGRICULTURAL EXPERIMENT STATION
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HIGHLIGHTS

Analysis of costs and returns of 26 Mississippi fluid milk plants showed an average net return of less than one and a half cents per dollar of sales in 1965, Figure 1. Eight of the 26 plants had a net loss on their operation. By plants, the net ranged from a loss of almost 10 cents per dollar of sales to a gain of almost 7 cents. Return on investment averaged 4.4 percent for the 25 plants from which investment data was obtained.

Cost of raw milk and other products used, such as sugars and flavors, averaged almost 55 cents per dollar of sales. About 95 percent of this cost was for the raw milk purchased for use in the fluid milk products.

Fifteen cents of the sales dollar, on the average, was accounted for by the cost of processing (cooling, pasteurizing, homogenizing and packaging) the product. On a cents-per-quart basis, these costs tended to decline from an average of about 5 cents in small plants to less than 3½ cents in plants that processed more than 25 million pounds of milk annually.

Selling and delivery costs were the second largest component of the sales dollar. These costs averaged 24 cents per dollar of sales for the plants in the study. The plants with volumes less than 5 million pounds annually had the lowest selling and delivery costs per unit on the average while the plants with volumes greater than 25 million pounds had the highest.

Administrative costs and plant losses accounted for almost 4½ cents per sales dollar. Slightly more than 3 cents of this amount was administrative cost.

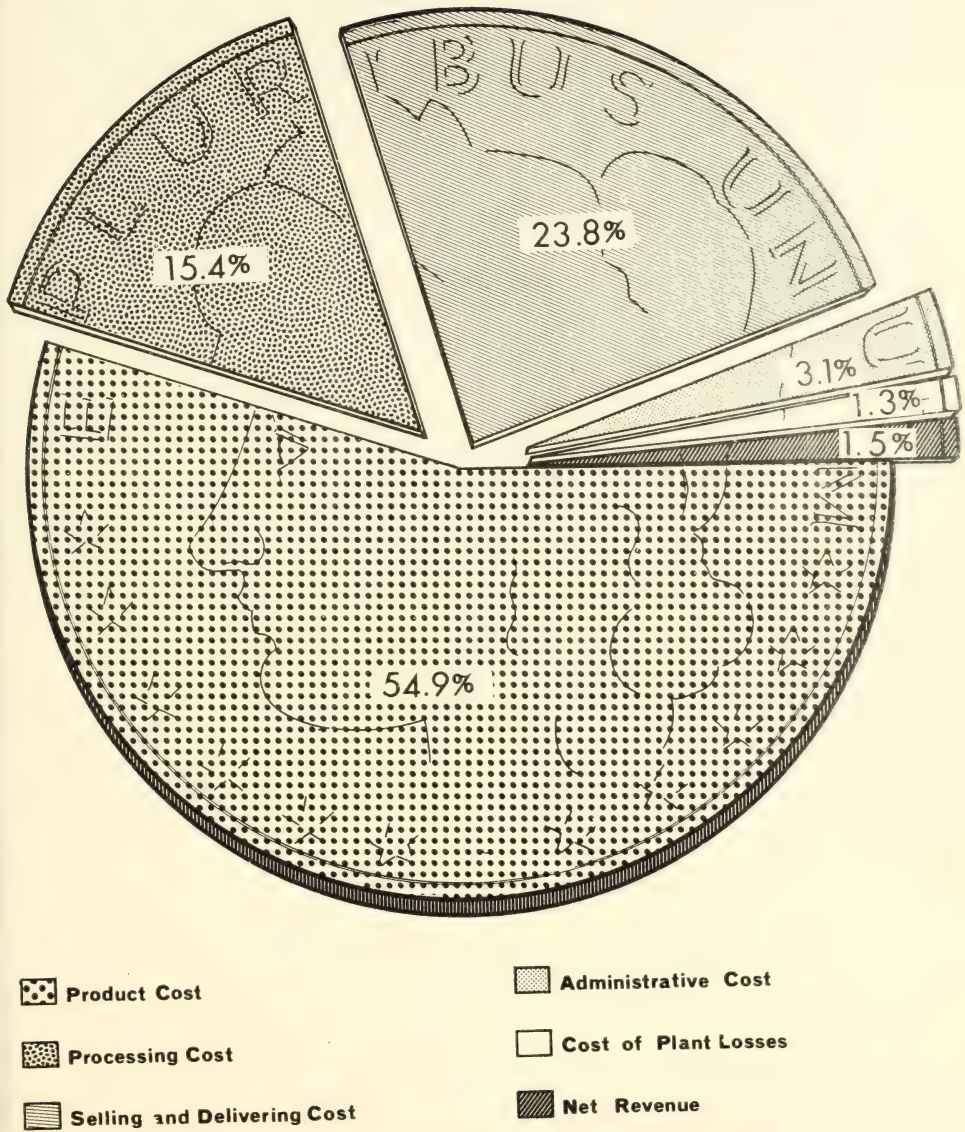


Figure 1. Distribution of the sales dollar, 26 handlers, Mississippi, 1965



COST OF PROCESSING AND
DISTRIBUTING GRADE "A" MILK
IN MISSISSIPPI

by

Verner G. Hurt

Prices Mississippi processors, grocers, and consumers pay for milk are regulated by the Mississippi Milk Commission. One of the duties given to the Commission by the Legislature in 1960 is the responsibility for investigating

" . . . the costs and charges for producing, hauling, bottling, packaging, distributing, processing, and marketing of milk and other services performed in relation to milk and . . ." determining " . . . reasonable charges and cost therefor, . . ." (Senate Bill No. 1757, Section 15(b), May 11, 1960).

In 1965, the Commission, in its efforts to obtain equitable guides for its regulatory activities, requested that the Department of Agricultural Economics, Mississippi State University, conduct a study of the average cost of processing and distributing milk in the State. This publication reports the findings of that study.

Procedure

Data pertaining to costs associated with processing and distributing fluid milk were obtained from 26 handlers located in Mississippi. These data were collected in 1966 by auditors employed by the Commission and were based upon the accounting records maintained by the handlers. The period covered by the cost data was January 1 - December 31, 1965 or the most recent fiscal year (covering a part of that period and subsequent months) for which data were available.

The Department of Agricultural Economics had the responsibility for analyzing the data and preparing the report. For purposes of analysis, handlers were grouped according to volume of milk processed. The number of handlers in each of the four groups delineated and the volume classes are shown in Table 1.

Table 1. Number of handlers by volume processed per year, Mississippi, 1965.

Group	Number of Handlers	Volume (million pounds)
I	7	less than 5
II	7	5 to 10
III	5	10 to 25
IV	7	more than 25

Not only were many different products (e.g., homogenized, skim, cream, chocolate, and buttermilk) processed by the plants in this study, but also these products were packaged in containers of different sizes (half-gallons, quarts, pints, third-quarts, half-pints). The cost data obtained could not be allocated to each specific product in each of the different container sizes. Consequently, a common unit of measure equivalent to a quart of fluid milk product was used in calculating the weighted average costs.

Throughout this report the term "quart equivalent" or "quart" refers to a volume of fluid milk processed rather than to a specific product in a particular container size. For example, either a quart of homogenized milk or four half-pints of chocolate are one quart equivalent of fluid milk product. Hence, the costs reported herein are averages over all products and all container sizes processed in the plants in the study. These costs thus cannot be interpreted as the costs per quart of any specific product in any particular container size.

In addition to cost data, information pertaining to the gross value of sales of fluid milk products and the investment of handlers was obtained for this study. Averages of these two items per quart equivalent have been calculated also.

Cost of Processing and Distributing

Fluid Milk

Four major cost centers were defined for this study: (1) product cost, (2) processing cost, (3) selling and delivery cost, and (4) administrative cost. Costs were further allocated to certain accounts within each of these cost centers in accordance with the procedure followed by the handlers and/or standard accounting practices.

Product Cost: "Product costs" includes the cost of the raw milk purchased, the cost of other products such as sugar, flavors, non-fat solids, and charges associated with the procurement of the raw milk supplies. These costs, averaging 13.5 cents per quart in the 26 plants, did not differ appreciably between plants in the different size groups, Figure 2. ^{1/} Average product cost ranged from 13.2 cents per quart for plants in Group III to 13.9 cents for plants in Group I. The net cost of the raw milk ^{2/} accounted for about 95 percent of the total product cost regardless of plant size.

Processing Cost: In general, the cost of processing per quart of fluid milk equivalent would be expected to decrease as the volume processed increased.

^{1/} For the details of the information presented in the figures in this and succeeding Sections, the reader is referred to the Appendix.

^{2/} The net cost of the raw milk was defined as the cost of milk purchases less milk and cream sales and hauling income.

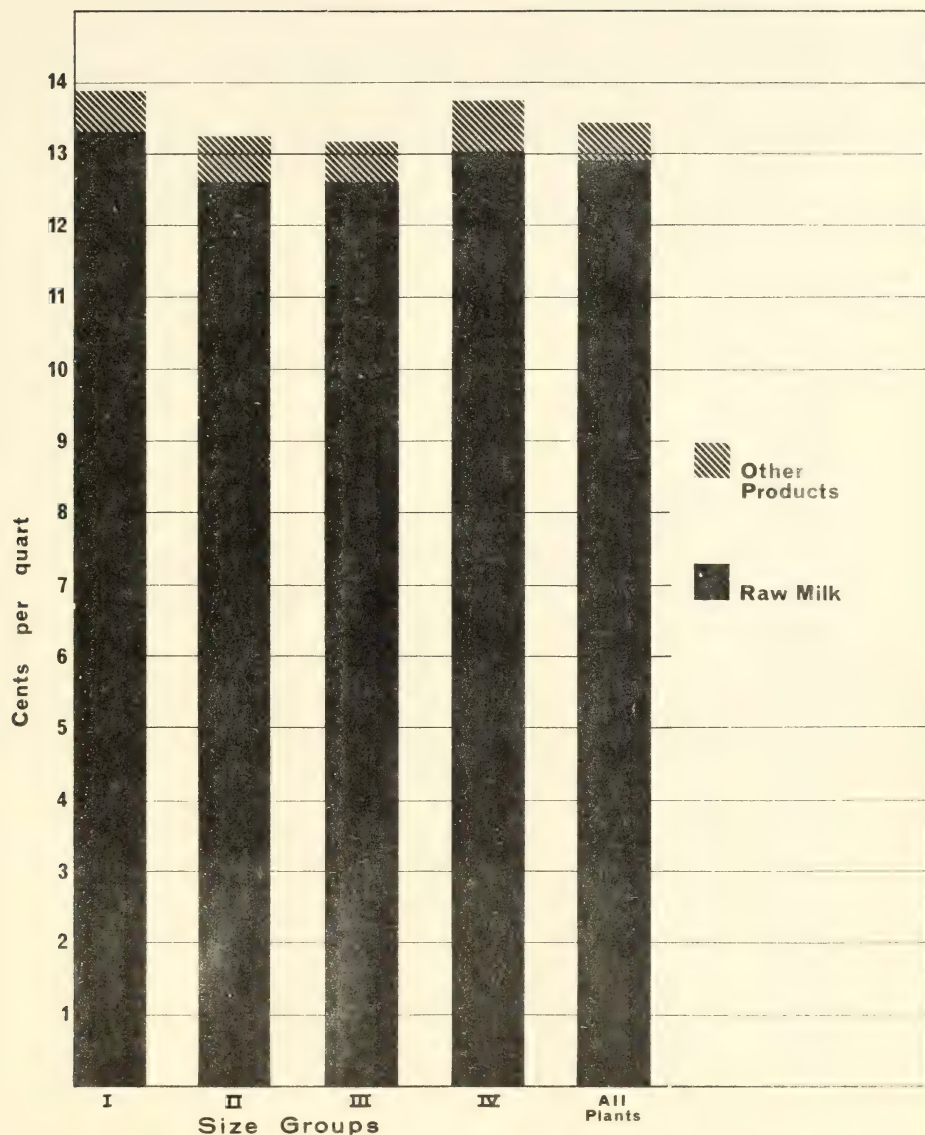


Figure 2. Product cost per quart, by size of plant, Mississippi, 1965

Such was the case, on the average, for the plants in this study. Weighted average processing costs per quart ranged from 5.2 cents for the small plants to 3.4 cents for the larger plants, Figure 3. For all plants the processing cost per quart equivalent averaged 3.8 cents.

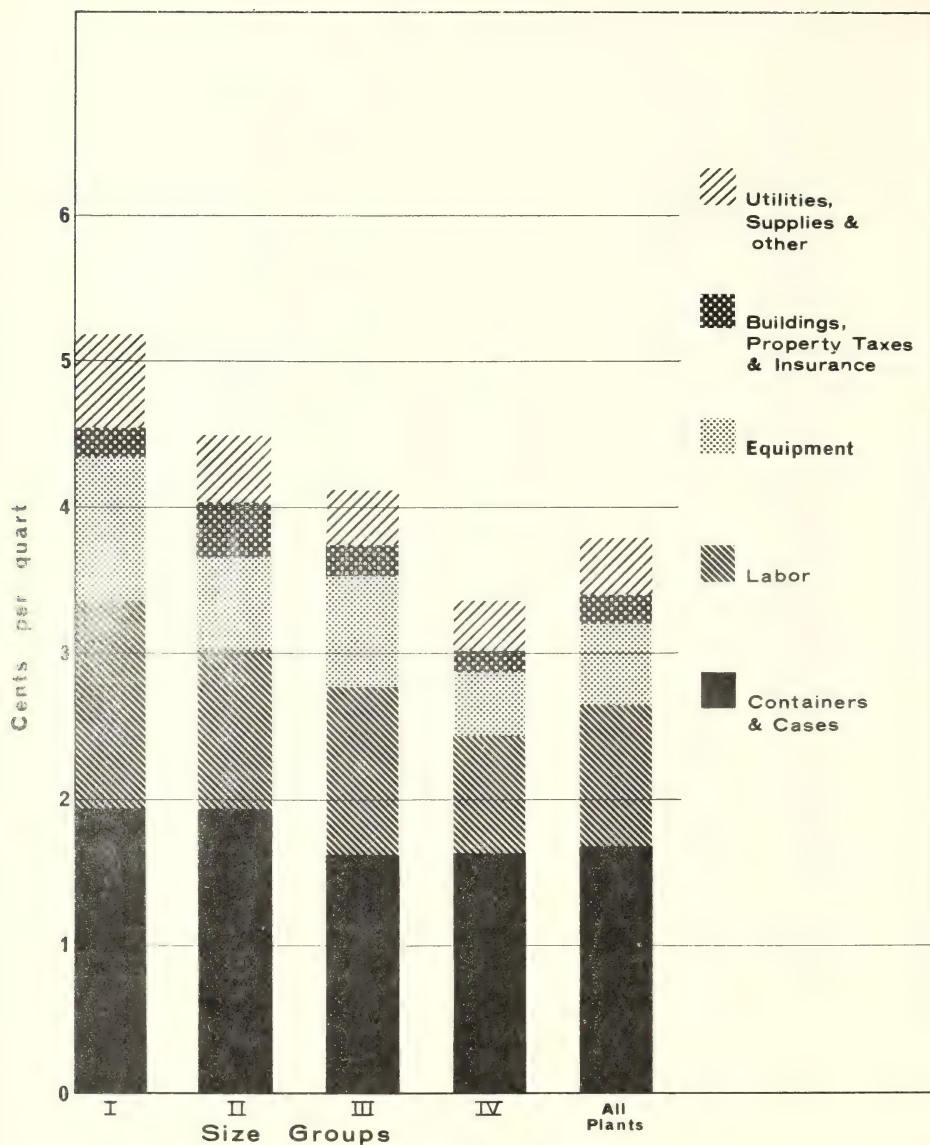


Figure 3. Processing cost per quart, by size of plant, Mississippi, 1965

Containers, at about 43 percent of the total, and labor, at 25 percent, were the two big items of processing costs.

Selling and Delivery Cost: To sell and deliver their products cost the 26 processors in the sample an average of 5.9 cents per quart. While increasing the volume handled might be

expected to lead to economies in these costs, many of the efforts exerted to increase volume can well give rise to a higher unit cost. To increase volume, processors may increase the size of their sales areas, make more home deliveries, or offer their sales personnel more attractive sales incentives--all practices that tend to push selling cost per unit up. The impact of these influences may be the reason that selling and delivery costs were, on the average, highest in the group of plants with the largest volumes. At 6.14 cents per quart, they exceeded by almost a cent and a quarter corresponding costs in plants with the least volumes, Figure 4.

Salaries accounted for about 50 percent of the total selling and delivery costs for each size group. Next in importance to salaries were those costs associated with the ownership and operation of delivery trucks. Some indication of the increases in costs from increases in the size of the distribution area are evidenced by the higher cost for gasoline, oil, tires, ect. for the plants in Group IV.

Administrative Costs: For the plants studied, the weighted average administrative cost did not appear to be related to the volume handled. Costs averaged the highest for plants in Group III, 1.1 cents per quart, and the lowest for plants in Group II, 0.7 cents per quart, Figure 5. For all plants studied, the weighted average administrative cost was 0.8 cents per quart equivalent of milk sold.

Total Costs: The average total cost per quart of milk sold tended to decrease as volume increased. Average costs ranged from 25.3 cents per quart for handlers in Group I to 23.9 cents per quart for those in Group III, Figure 6. For all plants, the average was 24.3 cents per quart.

Raw product cost made up more than half of the total cost, ranging from 53 to 57 percent of the total in plants of the various sizes. For the 26 handlers, product cost averaged about 56 percent of the total, Figure 5. The proportion of the total cost associated with processing declined as volume increased while the proportion associated with selling and delivery tended to increase.

Variability of Costs

Many different factors affect the level of costs within a particular plant and hence contribute to differences between plants in the average costs for the cost categories delineated. Some of the likely causes of cost differences and the extent of these differences by cost categories and by size groups are discussed below.

Product Cost: Differences in the average butterfat content of the final products sold may cause substantial differences in the cost per quart of the raw product between plants.

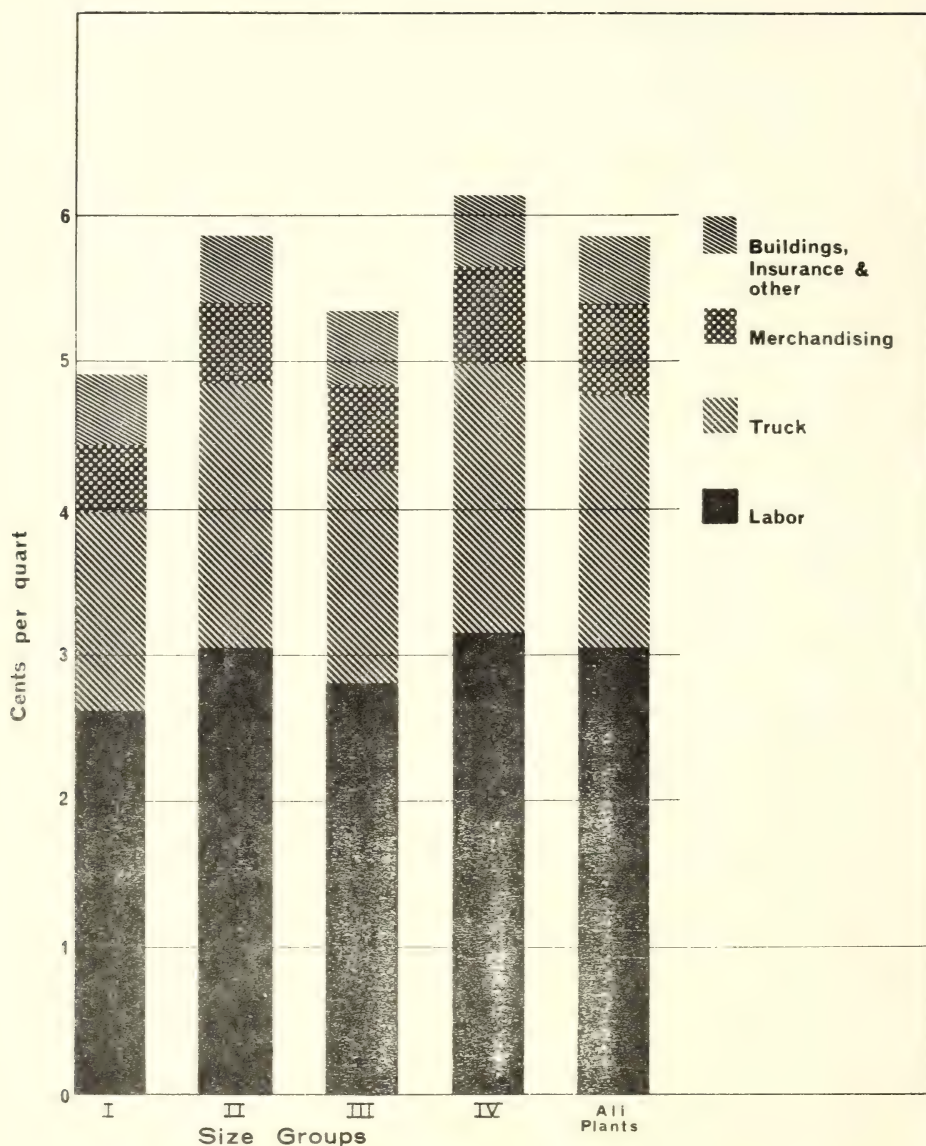


Figure 4. Selling and delivery cost per quart, by size of plant, Mississippi, 1965

Also, with plants operating under a system of milk marketing orders, location differentials within a particular order and differences in the level of Class I prices between orders are

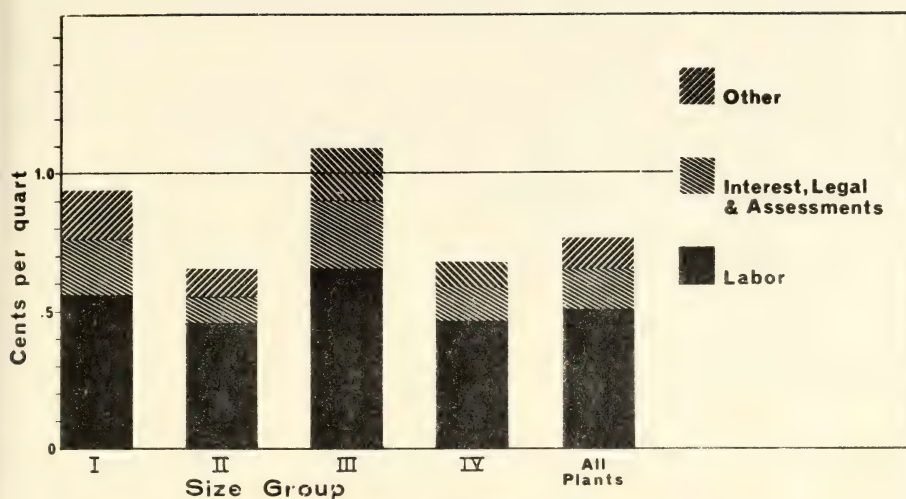


Figure 5. Administrative cost per quart, by size of plant, Mississippi, 1965

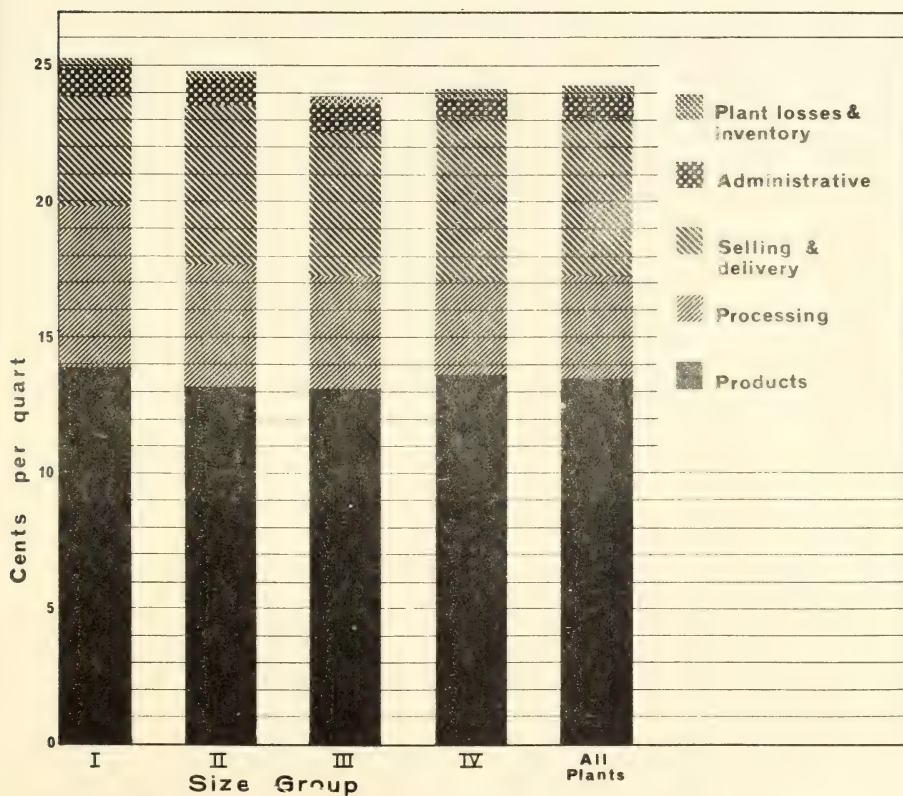


Figure 6. Total cost per quart, by size of plant, Mississippi, 1965

a source of variability in product cost per quart to the plants. Another source of variability may be plant differences in the proportion of the final product that chocolate and other flavored products constitute. These differences can result in different levels by plants in the cost of chocolate powder, sugar, and other such ingredients.

Table 2. Distribution of plants by average product cost per quart equivalent of fluid milk processed, by size groups, 26 handlers, Mississippi, 1965.

Average product cost (cents/quart)	Size group				All plants
	I	II	III	IV	
	- - - Number of plants - - -				
12.5 or less	0	1	1	1	3
12.6-13.5	1	5	2	2	10
13.6-14.5	5	0	2	2	9
14.6 or more	1	1	0	2	4

Average cost of the product per quart equivalent of fluid milk processed for the plants in the study ranged from 11.9 to 15.5 cents. Only three of the plants had costs per quart of 12.5 cents or less while costs for four of the plants were 14.6 cents per quart or more, Table 2. Nineteen of the 26 plants had average product costs of from 12.5 to 14.5 cents per quart equivalent.

Table 3. Distribution of plants by average processing cost per quart equivalent of fluid milk processed, by size groups, 26 handlers, Mississippi, 1965.

Average processing cost (cents/quart)	Size group				All plants
	I	II	III	IV	
	- - - Number of plants - - -				
3.5 or less	0	0	0	6	6
3.6-4.0	0	3	2	1	6
4.1-4.5	1	1	3	0	5
4.6-5.0	2	1	0	0	3
5.1 or more	4	2	0	0	6

Processing Cost: Cost of processing in individual plants varied from 3.1 to 5.7 cents per quart equivalent. Sources of variability in processing costs are (1) differences in the depreciation schedules followed, (2) differences in the extent to which the available capacity of the fixed assets are utilized, and (3) economies attained from processing larger volumes of product--to mention a few.

Economies associated with larger volume operations appear to have been a major source of variability in costs. For example, in six of the seven plants in Group IV (the group with the highest volume) processing costs per unit were 3.5 cents or less; in no plant with a smaller volume was processing costs that low, Table 3. In each of the 7 plants with volumes of 5

million pounds or less, these costs exceeded 4.0 cents; and in 6 of the 14 plants with volumes of 10 million pounds or less processing costs per quart exceeded 5.0 cents.

Table 4. Distribution of plants by average selling and delivery cost per quart equivalent of fluid milk sold, by size groups, 26 handlers, Mississippi, 1965.

	Size group				All
Average selling & delivery : (cents/quart)	I	II	III	IV	plants
	- - -Number of plants - - -				
5.0 or less	5	1	2	2	10
5.1-6.0	1	4	2	1	8
6.1-7.0	1	1	1	2	5
7.1 or more	0	1	0	2	3

Selling and Delivery Costs: The size of the sales area, the concentration of sales within an area, the proportion of total sales at retail, wholesale, and contract, the amount of advertising, and the depreciation schedules followed for delivery equipment are factors giving rise to variability between plants in per unit costs of selling and delivering fluid milk. Ten of the plants studied had selling and delivery expenses per quart of 5.0 cents or less, Table 4. That the size of the sales area was an important consideration is indicated by the fact that in five of the seven plants in the smallest group costs per quart were 5.0 cents or less, while in four of the seven largest plants these costs were more than 6.0 cents. For three of the plants selling and delivery costs per quart exceeded 7.0 cents. For all plants studied, selling and delivery costs ranged from 4.0 to 8.6 cents per quart.

Table 5. Distribution of plants by average administrative cost per quart equivalent of fluid milk sold, by size groups, 26 handlers, Mississippi, 1965.

	Size group				All
Average administrative cost : (cents/quart)	I	II	III	IV	plants
	- - -Number of plants - - -				
0.5 or less	1	3	0	3	7
0.6-1.0	4	2	4	2	12
1.1-1.5	1	2	0	2	5
1.5 or more	1	0	1	0	2

Administrative Costs: For the plants studied, administrative costs per quart sold varied from 0.4 to 1.7 cents per quart. This cost was 1.0 cents per quart or less for about two-thirds of the plants (19 of 26), Table 5. Some factors contributing to the variability observed may have been (1) differences in salary levels or management, (2) differences in accounting procedures among plants, and (3) for those plants where ownership and management were the same, returns to ownership may have been taken as salaries rather than as profits to the business.

Total Costs: All the factors that contribute to variations in the costs per unit by categories also affect total costs. For the plants in the study, total costs per quart ranged from 20.7 to 27.8 cents. That volume handled was an important source of variability in unit costs between plants is indicated by five of the seven largest plants, but only one of the seven smallest plants with costs less than or equal to 24.5 cents per quart sold, Table 6. Costs exceeded 25.5 cents per quart sold in seven of the twenty-seven plants.

Table 6. Distribution of plants by average total cost per quart equivalent fluid milk sold, by size groups, 26 handlers, Mississippi, 1965.

Average total cost (cents/quart)	Size group					All plants
	I	II	III	IV		
	Number of plants					
24.0 or less	0	2	3	3		8
24.1-24.5	1	1	0	2		4
24.6-25.0	1	2	1	0		4
25.0-25.5	2	0	0	1		3
25.6 or more	3	2	1	1		7

Sales, Investment and Net Returns

Sales: Handlers in the study averaged receiving 24.6 cents per quart equivalent for the fluid milk they sold, Figure 7.

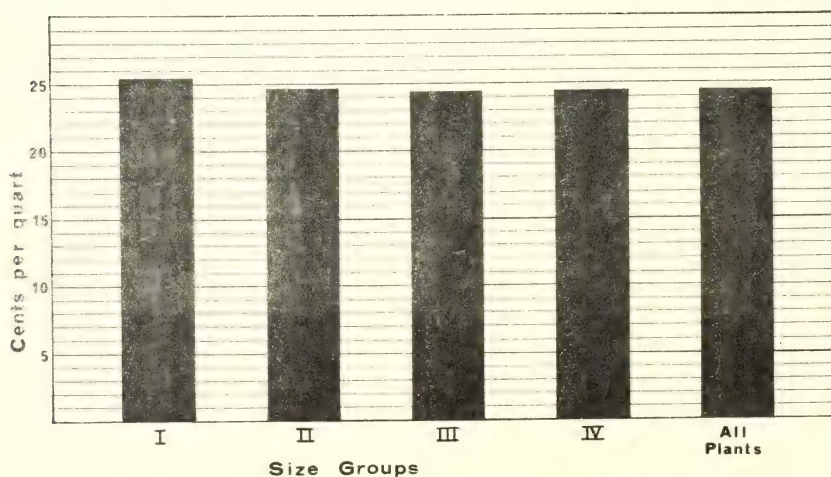


Figure 7. Value of sales per quart, by size of plant, Mississippi, 1965

By size groups, the average value of sales per quart ranged from 24.4 cents for handlers in Group III to 25.5 cents for handlers in Group I. For all plants in the study, the value of sales per quart equivalent ranged from 21.3 cents to 27.1 cents. Four of the plants received 24 cents or less and four 26 cents or more per quart equivalent of milk sold, Table 7.

Investment: The 25 handlers from which investment information was obtained had an average of 8.2 cents invested in facilities and equipment per quart equivalent of fluid milk sold, Figure 8. By size groups, the average investment per quart ranged from 7.7 to 8.3 cents, with the plants in Group I having the lowest average investment. Ten of the 25 handlers had more than 9 cents per quart invested while 8 had 7 cents or less invested per quart, Table 8.

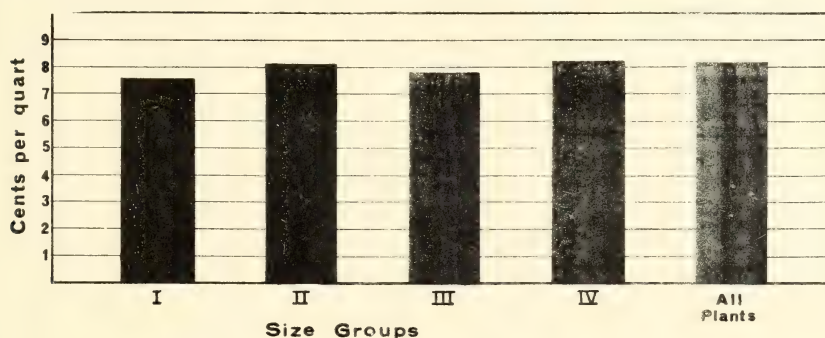


Figure 8. Investment per quart, by size of plant, Mississippi, 1965

Table 7. Distribution of plants by average value of sales per quart equivalent of fluid milk sold, by size groups, 26 handlers, Mississippi, 1965.

Average valued sales (cents/quart)	Size group				All plants
	I	II	III	IV	
	- - - Number of plants - - -				
24.0 or less	0	1	2	1	4
24.1-25.0	1	3	2	3	9
25.1-26.0	4	2	1	2	9
26.0 or more	2	1	0	1	4

Table 8. Distribution of plants by average investment per quart equivalent of fluid milk sold, by size groups, 25 handlers, Mississippi, 1965.

Average investment (cents/quart)	Size group				All plants
	I	II	III	IV	
	- - - Number of plants - - -				
7.0 or less	2	1	2	3	8
7.1-8.0	1	3	0	1	5
8.1-9.0	1	0	1	0	5
9.1 or more	3	2	2	3	10

Net Returns: ^{1/} For all of the plants in the study, the average net return was 0.4 cents per quart of fluid milk equivalent sold, Figure 9.

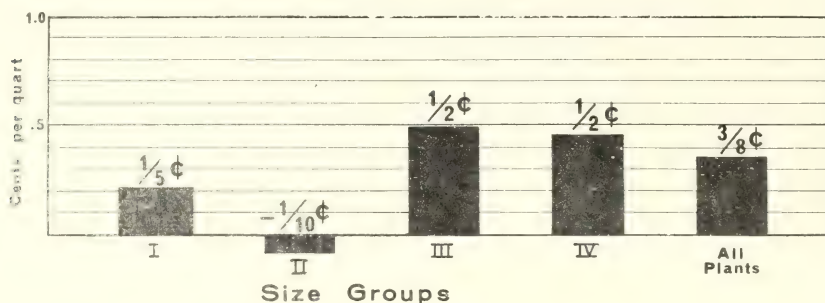


Figure 9. Net returns per quart, by size of plant, Mississippi, 1965

Plants in Group II had an average loss of about 0.1 cent per quart. Plants in the other three groups, on the average, had a net gain ranging from 0.2 cent per quart for those in Group I to almost 0.5 cent per quart for those in Group III. Eight of the 26 plants studied had a net loss on the milk sold, while three had a net gain of more than one cent per quart, Table 9. Actually, variations in net revenues were less than one could have been led to expect from the variability of total cost and value of sales. Generally, those plants with low costs also had a low value of sales per unit and vice versa.

Table 9. Distribution of plants by net returns per quart equivalent of fluid milk processed, by size groups, 26 handlers, Mississippi, 1965.

Average net returns (cents/quart)	Size group				All plants
	I	II	III	IV	
	- - - Number of plants - - -				
Net loss	1	4	2	1	8
0.1-0.5	4	1	1	3	9
0.6-1.0	2	1	1	2	6
1.1 or more	0	1	1	1	3

Net Return on Sales and Investment: Average net returns per dollar of sales by size groups ranged from a loss of 0.4 percent for plants in Group II to a gain of 2.0 percent for plants in Group III, Table 10. The average for all plants was 1.5 percent. Net return per dollar invested averaged 4.4 percent for all plants, Table 10. Plants in Group II had a loss of 1.1 percent, on the average, while those in Group III had a net return of 6.2 percent on investment.

^{1/} For this study, net returns are defined as the difference between the value of sales and total cost per quart equivalent of fluid milk sold. Individual and corporate income taxes are not included in the total costs.

Table 10. Net returns per dollar of sales and per dollar invested, by size groups, 26 handlers, Mississippi, 1965.

Item	Size group				All plants
	I	II	III	IV	
	- - - - - Percent - - - - -				
Net return per dollar of sales	0.87	-0.35	1.98	1.87	1.46
Net return per dollar invested ^{1/}	2.92	-1.09	6.15	5.57	4.43

^{1/} Based on six plants in Group II and 25 plants total.
Investment data was not obtained from one plant.

APPENDIX

Appendix Table 1. PRODUCT COSTS: Weighted average per quart equivalent of fluid milk processed, by size groups, 26 handlers, Mississippi, 1965.

Description	Size group				
	I	II	III	IV	All plants
- -Cents per quart - -					
Raw milk costs					
Milk purchases	14.14	13.84	13.14	13.48	13.52
Less milk and cream sales	0.75	0.98	0.47	0.27	0.45
Less hauling income	0.13	0.20	0.11	0.17	0.17
SUB-TOTAL	13.26	12.66	12.56	13.04	12.90
Other products and procurement costs					
Chocolate powder	0.13	0.12	0.13	0.08	0.10
Sugar	0.24	0.16	0.10	0.20	0.18
Milk powder	0.04	0.08	0.18	0.08	0.09
Sour cream	0.00	0.05	0.08	0.11	0.09
Milk audit account	0.18	0.04	0.00	0.02	0.03
Procurement salaries	0.04	0.10	0.12	0.16	0.14
Payroll taxes	0.00	0.01	0.00	0.01	0.01
SUB-TOTAL	0.63	0.56	0.61	0.66	0.64
TOTAL	13.89	13.22	13.17	13.70	13.54

Appendix Table 2. PROCESSING COSTS: Weighted average per quart equivalent of fluid milk processed, by size groups, 26 handlers, Mississippi, 1965.

Description	Size group					All plants
	I	II	III	IV		
	- - - Cents per quart - - -					
Containers and cases						
Containers	1.91	1.92	1.60	1.54	1.63	
Cases	0.03	0.01	0.01	0.08	0.05	
SUB-TOTAL	1.94	1.93	1.61	1.62	1.68	
Labor						
Salaries	1.35	1.04	1.09	0.78	0.91	
Payroll taxes	0.06	0.05	0.07	0.04	0.05	
SUB-TOTAL	1.41	1.09	1.16	0.82	0.96	
Equipment						
Repairs and maintenance	0.24	0.16	0.12	0.15	0.15	
Rental or lease	0.45	0.36	0.30	0.15	0.23	
Depreciation	0.30	0.13	0.34	0.13	0.18	
SUB-TOTAL	0.99	0.65	0.76	0.43	0.56	
Buildings, property taxes and insurance						
Repairs and maintenance	0.02	0.11	0.04	0.01	0.03	
Rental or lease	0.04	0.03	0.01	0.03	0.03	
Depreciation	0.07	0.13	0.07	0.06	0.08	
Property taxes	0.04	0.05	0.04	0.02	0.03	
Insurance	0.03	0.04	0.04	0.03	0.03	
SUB-TOTAL	0.20	0.36	0.20	0.15	0.20	
Other processing costs						
Utilities	0.39	0.22	0.17	0.16	0.18	
Freight-in	0.03	0.01	0.01	0.01	0.01	
Plant Supplies	0.21	0.20	0.17	0.12	0.15	
Milk analysis	0.01	0.02	0.02	0.03	0.03	
Laundry and uniforms	0.01	0.01	0.02	0.02	0.02	
SUB-TOTAL	0.65	0.46	0.39	0.34	0.39	
TOTAL	5.19	4.49	4.12	3.36	3.79	

Appendix Table 3. SELLING AND DELIVERY COSTS: Weighted average per quart equivalent of fluid milk sold, by size groups, 26 handlers, Mississippi, 1965.

Description	Size groups					All
	I	II	III	IV	plants	
	- - Cents per quart - -					
Labor						
Salaries	2.50	2.91	2.65	2.99	2.89	
Payroll taxes	0.11	0.14	0.17	0.17	0.16	
SUB-TOTAL	2.61	3.05	2.82	3.16	3.05	
Truck expense						
Repairs and maintenance	0.48	0.60	0.26	0.43	0.43	
Gas, oil, tires, eat.	0.48	0.75	0.70	0.96	0.85	
Depreciation	0.35	0.36	0.43	0.36	0.37	
Taxes and licenses	0.07	0.08	0.05	0.09	0.08	
SUB-TOTAL	1.38	1.79	1.44	1.83	1.73	
Merchandising expense						
Advertising	0.26	0.35	0.37	0.39	0.37	
Royalties	0.00	0.00	0.01	0.03	0.02	
Bad debts, allowances & adj.	0.06	0.09	0.04	0.11	0.09	
Customer solicitation	0.01	0.01	0.05	0.03	0.03	
Travel and entertainment	0.02	0.04	0.01	0.05	0.04	
Sales Tax	0.08	0.08	0.09	0.07	0.08	
SUB-TOTAL	0.43	0.57	0.57	0.67	0.63	
Buildings, insurance and other						
Depreciation, buildings	0.02	0.02	0.00	0.01	0.01	
Depreciation, outside coolers	0.01	0.00	0.00	0.01	0.01	
Depot repairs, tax and rental	0.00	0.04	0.07	0.03	0.04	
Insurance	0.24	0.18	0.19	0.11	0.14	
Utilities	0.03	0.03	0.02	0.06	0.04	
Telephone and telegraph	0.06	0.09	0.06	0.05	0.06	
Laundry and uniforms	0.03	0.03	0.04	0.04	0.04	
Office supplies and postage	0.06	0.05	0.05	0.07	0.06	
Misc. supplies and expense	0.04	0.03	0.07	0.08	0.07	
SUB-TOTAL	0.49	0.47	0.50	0.46	0.47	
TOTAL	4.91	5.88	5.33	6.14	5.88	

Appendix Table 4. ADMINISTRATIVE COSTS: Weighted average per quart equivalent of fluid milk sold, by size groups, 26 handlers, Mississippi, 1965.

Description	Size group				All
	I	II	III	IV	plants
- -Cents per quart - -					
Labor					
Salaries	0.52	0.40	0.58	0.32	0.39
Payroll taxes	0.02	0.02	0.04	0.01	0.02
Employee benefits	0.03	0.04	0.04	0.14	0.10
SUB-TOTAL	0.57	0.46	0.66	0.47	0.51
Interest, legal and assessments					
Interest	0.06	0.03	0.10	0.05	0.05
Legal and audit	0.07	0.03	0.06	0.01	0.03
Administrative assessments	0.07	0.04	0.07	0.05	0.06
SUB-TOTAL	0.20	0.10	0.24	0.11	0.14
Other administrative expense					
Travel and entertainment	0.02	0.01	0.06	0.01	0.02
Dues and subscriptions	0.06	0.04	0.03	0.02	0.03
Utilities	0.01	0.00	0.01	0.01	0.01
Office equipment, repairs and rental	0.01	0.01	0.02	0.03	0.02
Office equipment, depreciation	0.02	0.01	0.02	0.01	0.01
Misc. expense and donations	0.05	0.03	0.05	0.02	0.03
SUB-TOTAL	0.17	0.10	0.19	0.10	0.12
TOTAL	0.94	0.66	1.09	0.68	0.77

Appendix Table 5. TOTAL COSTS: Weighted average per quart equivalent of fluid milk sold, by size groups, 26 handlers, Mississippi, 1965.

Description	Size group				All plants
	I	II	III	IV	
	- - - Cents per quart - - -				
Product	13.89	13.22	13.17	13.70	13.5
Processing	5.19	4.49	4.12	3.36	3.7
Selling and delivery	4.91	5.88	5.33	6.14	5.8
Administrative	0.94	0.66	1.09	0.68	0.7
Plant losses and inventory charge	0.34	0.63	0.22	0.24	0.3
TOTAL	25.27	24.88	23.93	24.12	24.2
	- - - Percentage of total cost - - -				
Product	55.0	53.1	55.1	56.8	55.7
Processing	20.6	18.1	17.2	14.0	15.6
Selling and delivery	19.4	23.7	22.2	25.4	24.2
Administrative	3.7	2.6	4.6	2.8	3.2
Plant losses and inventory charge	1.3	2.5	0.9	1.0	1.3
TOTAL	100.0	100.0	100.0	100.0	100.0

Appendix Table 6. SALES, INVESTMENT, AND NET RETURNS: Weighted average per quart equivalent of fluid milk sold by size groups, 26 handlers, Mississippi, 1965

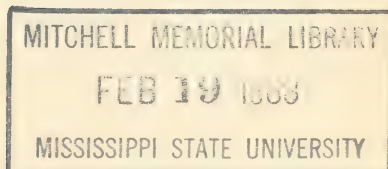
Description	Size group				All plants
	I	II	III	IV	
	- - - Cents per quart - - -				
Sales	25.49	24.79	24.42	24.56	24.64
Less total cost	25.27	24.88	23.93	24.12	24.28
Net returns	0.22	-0.09	0.49	0.46	0.36
Investment ^{1/}	7.67	8.13	7.88	8.28	8.15

^{1/} Based on six plants in Group II and 25 plants total.



The Effects of Restricted Feeding On the Performance of Different Strains of Commercial Layers

By CHARLES H. THOMAS and
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MISSISSIPPI

Summary

This experiment was designed to study the effects of restricting the feed of pullets from 8 to 26 weeks of age. Six commercial layer strains were used, and they were housed in one cage unit and two floor units. One-half of each strain was full fed and the other half received 8 pounds of mash and 2.5 pounds of oats per 100 birds daily from 8 to 26 weeks of age. All birds were full fed at all other times from day of age to two years of age.

Mortality from 8 to 26 weeks of age was approximately twice as high in the restricted fed group as the full fed group; however, mortality was slightly lower in the restricted fed group in the laying house.

Although there was a highly significant difference in body weight at 20 weeks of age (full fed birds 0.56 pounds heavier), this difference was not significant at 2 years of age.

The full fed birds reached 5% production 39 days and 50% production 20 days before the restricted fed birds.

The mean egg production of the full fed group was 275 eggs and of the restricted fed group 288 eggs. The full fed birds laid over 10 times as many peewee and over three times as many small eggs as the restricted fed birds.

Labor income per bird was approximately \$0.50 more from the restricted fed birds than the full fed birds.

Although the difference between houses for egg production was not significant, the mean egg production of the birds in the cage house was higher than the birds in the floor units.

These results indicate that restricting the feed as done in this series of test will reduce the number of small and peewee eggs and increase the number of large and extra large eggs of birds with different genetic makeup.

THE EFFECT OF RESTRICTED FEEDING ON THE PERFORMANCE OF DIFFERENT STRAINS OF COMMERCIAL LAYERS

By CHARLES H. THOMAS and R. C. ALBRITTON*

Previous research by the Mississippi Station has shown that restricting the feed of pullets between the ages of 8 and 26 weeks delays sexual maturity and reduces the number of small and peewee eggs. The object of the experiment reported here was to determine if six different strains of commercial layers would perform similarly under two different feeding methods.

Six strains of day-old chicks, with approximately 500 birds per strain, were started in each of two successive trials. The same six strains were used in each of the two-year trials. All birds were fed starting mash *ad libitum* to 8 weeks of age. At 8 weeks of age each strain was equally divided into two groups—one for full and one for restricted feeding. Plastic specs were used to prevent cannibalism and all the birds were reared in confinement throughout the experiment.

The full fed groups were given all the growing mash and oats they would eat. The restricted group were limited to 8 pounds of mash and 2.5 pounds of oats per 100 birds daily from 8 to 26 weeks of age in each trial. At 20 weeks of age each group was randomly divided into three housing groups. One group was housed in cages (10 x 18 inches) and two groups were placed in floor units (approximately 2.5 square feet per bird). All were fed an all mash

laying ration from 26 weeks of age to two years in each trial.

All birds were vaccinated for Newcastle and bronchitis at 4 days, 4 weeks, and 4 months of age and for fowl pox at 8 weeks of age.

The birds were weighed at 8 and 20 weeks and 2 years of age. Feed consumption and mortality was recorded for each group, and all eggs were classified daily into the following weight classes: extra large, large, medium, small, and peewee. Egg production for each group was recorded from the first egg to 2 years of age. The birds received approximately 14 hours of light daily in the laying house.

In determining the cost and income the following prices were used: chick cost \$0.35, starting mash \$4.40 per 100 pounds, growing mash \$4.00 per 100 pounds, oats \$2.95 per 100 pounds, laying mash \$3.61 per 100 pounds, brooding and vaccination \$0.04 per bird, extra large and large eggs \$0.42 per dozen, medium \$0.36 per dozen, small \$0.30 per dozen, peewee \$0.24 per dozen, and old hens \$0.10 per pound. The cost to 26 weeks of age was based on the number of birds alive at 26 weeks of age and the feed consumed per 100 birds was based on the number of birds alive at 26 weeks.

Mortality

From 0 to 8 weeks mortality was approximately the same for both trials (5.36 and 5.90%) with some variation between strains in each trial. From 8 to 20 weeks, mortality was approximately three times as high in Trial 2 as Trial 1; however, the mor-

*Poultryman, Experiment Station, State College, and Superintendent Northeast Mississippi Branch Experiment Station, respectively.

¹Thomas and Albritton 1959, 1960, 1963.

tality was approximately twice as high in the restricted fed group as the full fed group in both trials (Table 1). From 20 to 26 weeks mortality was 0.70% for the full fed group and 4.02% for restricted fed group in Trial 1 and approximately 1.3% in Trial 2 for both groups. Although the mortality from 26 weeks to 2 years of age was slightly less in the restricted fed group in both trials, the difference was only 1.27%. The cage house had the lowest average mortality for the two trials; however, most of the difference in mortality between houses was in Trial 2.

Feed Consumption

Although the average number of pounds of feed consumed per bird from 8 to 26 weeks of age is shown as 19.03 and 19.14 in Trials 1 and 2, respectively, for the full fed groups and 13.59 and 13.87 for Trials 1 and 2, respectively for the restricted fed group, the actual consumption per bird was slightly less because the mean feed consumption was based on the number of birds alive at 26 weeks of age (Table 2). The actual amount of feed fed per bird from 8 to 26 weeks of age was 13.23 pounds of feed for the restricted fed group. Since the restricted fed group consumed approximately 5.5 pounds of feed less than the full fed group, a savings of approximately \$0.22 in feed cost per bird was

realized. This savings in feed cost would more than offset the higher chick cost resulting from higher mortality in the restricted fed group.

Body Weight

The mean 8 week body weight was 1.22 pounds (Table 3). The difference in body weight at 20 weeks of age was 0.56 pounds which was highly significant (Table 4). The difference between strains and trials was not significant at 20 weeks. Although the full fed birds were still heavier in both trials at 2 years of age (0.07 pounds), the difference was not significant (Table 3). The birds in cages had an average weight of approximately 0.3 of a pound more than the birds in the two floor units.

Age At Sexual Maturity

Although the full fed birds reached 5% production 39 days before the restricted fed birds, there was a difference of only 20 days between the ages at 50% production because the full fed birds did not reach 50% production for approximately 30 days after 5% production. The restricted birds reach 50% production approximately 10 days after 5% production (Table 5). The difference between treatments was highly significant at 5% and 50% production; however, the other sources of variation were not significant (Table 7).

Table 1. Percent Mortality.

Weeks	Trial	Strain								Treatment		House		Mean
		1	2	3	4	5	6	F	R	Cage	Floor			
0-8	1	4.96	3.67	3.92	4.22	8.04	7.32	.....	.....	.....	.....	.....	.....	5.36
	2	9.85	3.66	4.43	7.03	5.36	5.19	.....	.....	.....	.....	.....	.....	5.96
	Mean	7.40	3.66	4.18	5.62	6.65	6.26	.....	.....	.....	.....	.....	.....	5.63
8-20	1	5.24	2.00	2.65	2.63	1.49	3.80	1.71	4.24	.....	.....	.....	.....	2.97
	2	12.21	4.60	12.30	11.34	7.00	9.94	6.10	12.96	.....	.....	.....	.....	9.53
	Mean	8.72	3.30	7.48	6.98	4.24	6.87	3.90	8.60	.....	.....	.....	.....	6.25
20-26	1	3.21	1.23	1.26	3.31	1.94	3.08	0.70	5.02	.....	.....	.....	.....	2.32
	2	1.22	2.94	0.02	0.07	1.33	1.35	1.31	1.34	.....	.....	.....	.....	1.33
	Mean	2.22	2.08	0.64	1.69	1.64	2.22	1.01	2.68	.....	.....	.....	.....	1.84
26-2 yrs.	1	15.17	12.63	9.77	12.64	22.64	16.56	15.78	13.78	15.69	14.70	14.58	14.83	14.83
	2	24.94	9.50	47.47	15.99	22.42	35.39	26.09	25.55	17.40	22.91	32.79	25.84	25.84
	Mean	20.06	11.06	29.63	14.33	22.53	25.98	30.94	19.67	16.54	18.80	23.68	20.34	20.34

¹F full fed, R restricted.

Egg Production

The mean egg production was higher for the restricted fed birds than for the all fed birds in both trials, and was higher for the birds in the cages than

for either floor unit in both trials. The mean egg production ranged from 268 to 299 for the six strains (Table 6). The difference between strains was highly significant for extra large and large and

Table 2. Pounds of feed consumed per 100 birds (based on number alive at 26 weeks of age).

Weeks	Treatment	Trial	Strain						Mean
			1	2	3	4	5	6	
1-8 Mash		1	522	521	523	527	555	558	534
		2	370	370	370	370	370	370	370
1-20 Mash	F	1	1086	1056	1120	1068	1109	1104	1090
	R	1	743	685	683	682	683	697	696
	F	2	1040	930	989	1036	969	970	989
	R	2	722	689	733	727	713	727	719
	F	1	-----	-----	-----	-----	-----	-----	-----
	R	1	231	214	212	212	213	217	216
Oats	F	2	162	142	153	159	148	149	152
	R	2	226	215	228	227	222	227	224
3-20 Total	F	1	1086	1056	1120	1068	1109	1104	1090
	R	1	974	899	895	894	896	915	912
	F	2	1202	1072	1142	1195	1117	1119	1141
	R	2	948	904	961	954	935	954	943
20-26 Mash	F	1	799	815	804	795	811	852	813
	R	1	347	340	340	345	342	343	343
	F	2	723	696	675	699	738	658	698
	R	2	337	340	337	338	345	343	340
	F	1	-----	-----	-----	-----	-----	-----	-----
	R	1	108	107	106	108	107	107	107
Oats	F	2	83	56	89	86	50	85	75
	R	2	102	105	101	103	105	106	104
20-26 Total	F	1	799	815	804	795	811	852	813
	R	1	455	447	446	453	449	450	451
	F	2	806	752	764	785	788	743	773
	R	2	439	445	438	441	450	449	444
0-26 Total	F	1	2407	2392	2447	2390	2475	2514	2437
	R	1	1951	1867	1864	1874	1900	1922	1893
	F	2	2378	2194	2276	2350	2275	2232	2284
	R	2	1757	1719	1769	1765	1755	1773	1757
8-26 Total	F	1	1875	1871	1924	1863	1920	1956	1903
	R	1	1429	1346	1341	1367	1345	1364	1359
	F	2	2008	1824	1906	1980	1905	1862	1914
	R	2	1387	1329	1399	1395	1335	1403	1387

¹F full fed, R restricted.

Table 3. Mean body weight (Pounds).

	Trial	Strain						Treatment		House			Mean
		1	2	3	4	5	6	F	R	A	B	C	
8 wks.	1	1.20	1.20	1.21	1.19	1.37	1.31						1.25
	2	1.20	1.20	1.26	1.08	1.26	1.20						1.20
	Mean	1.20	1.20	1.24	1.14	1.32	1.26						1.22
20 wks.	1	2.49	2.49	2.79	2.43	2.66	2.38	2.89	2.19				2.54
	2	2.53	2.51	2.54	2.52	2.54	2.46	2.72	2.30				2.52
	Mean	2.51	2.50	2.66	2.48	2.50	2.42	2.80	2.24				2.51
2 yrs.	1	4.02	3.89	3.76	4.01	4.14	4.12	4.03	3.93	4.20	3.96	3.91	3.98
	2	4.48	3.96	4.12	4.18	3.91	4.00	4.12	4.05	4.42	4.04	3.96	4.09
	Mean	4.25	3.93	3.94	4.10	4.02	4.06	4.08	3.99	4.31	4.00	3.94	4.04

Table 4. Analysis of variance for 20 week body weight.

Source	d. f.	M.S.
Total	23	
Strains	5	3.28
Treatments	1	187.60
Strain X Treatments	5	0.88
Trials	1	0.57
Error	11	2.63

Table 5. Age at 5% and 50% Production.

Trial		Strain				Treatment				House			Mean
		1	2	3	4	5	6	F	R	A	B	C	
Age 5% Prod.	1	187	177	180	182	180	177	163	197	177	182	182	181
	2	182	177	183	183	176	183	159	202	183	179	180	181
	Mean	185	177	182	182	178	180	161	200	180	180	181	181
Age 50% Prod.	1	208	204	195	198	199	202	192	210	197	203	203	203
	2	201	200	204	205	197	210	191	213	203	201	203	203
	Mean	204	202	200	202	198	206	192	212	200	202	203	203

Table 6. Mean egg production, pounds of feed per dozen eggs and percent of each size of egg

Strain	Trial	Mean egg prod.	Lbs. of feed per doz. eggs	Extra large	Large	Medium	Small	Pee-wee
1	1	273	5.56	80.25	15.47	3.33	0.34	0.0
	2	270	6.17	47.05	45.12	6.94	0.74	0.1
	Mean	271	5.87	63.65	30.30	5.37	0.54	0.1
2	1	301	4.47	75.12	18.83	5.20	0.65	0.2
	2	297	5.00	44.57	46.40	7.96	0.91	0.1
	Mean	299	4.74	59.84	32.62	6.54	0.77	0.1
3	1	298	4.65	71.62	21.33	6.17	0.77	0.1
	2	235	5.81	51.80	41.37	6.26	0.49	0.0
	Mean	268	5.23	61.71	31.35	6.21	0.65	0.0
4	1	298	4.69	72.50	21.24	5.63	0.54	0.0
	2	275	5.97	43.55	48.30	7.50	0.55	0.1
	Mean	287	5.33	58.02	34.77	6.48	0.55	0.0
5	1	285	4.96	75.77	17.77	5.55	0.74	0.1
	2	281	5.54	52.47	41.14	5.43	0.79	0.1
	Mean	283	5.25	64.12	29.46	5.52	0.76	0.1
6	1	305	4.82	77.85	17.53	4.01	0.45	0.1
	2	246	5.00	44.27	48.02	6.92	0.69	0.1
	Mean	276	4.91	61.06	32.78	5.30	0.56	0.1
Treatment:								
Full Fed	1	291	4.74	73.50	19.31	6.03	0.187	0.22
	2	258	5.71	45.31	44.86	8.48	1.14	0.21
	Mean	275	5.23	59.40	32.09	7.17	0.99	0.22
Restricted	1	297	4.94	77.32	18.28	4.09	0.29	0.01
	2	278	5.72	49.14	45.30	5.26	0.27	0.02
	Mean	288	5.34	63.23	31.79	4.46	0.28	0.02
House Cage	1	315	4.54	75.28	18.84	5.10	0.63	0.15
	2	304	5.36	50.98	43.50	4.98	0.45	0.08
	Mean	310	4.95	63.13	31.17	5.04	0.54	0.12
Floor	1	290	4.95	74.86	19.15	5.22	0.66	0.12
	2	272	5.68	45.98	45.78	7.34	0.76	0.14
	Mean	281	5.32	60.42	32.47	6.22	0.71	0.13
Floor	1	288	4.86	75.88	18.48	5.02	0.50	0.12
	2	246	5.95	46.40	45.25	7.45	0.79	0.11
	Mean	267	5.41	61.14	31.87	6.09	0.63	0.12
	1	294	4.84	75.35	18.81	5.11	0.59	0.13
	2	268	5.72	47.22	45.08	6.87	0.71	0.12
	Mean	281	5.28	61.29	31.94	5.93	0.64	0.12

Table 7. Analysis of variance for age at 5 and 50% production, egg production, percent of each size, and 2 year body weight.

Source	d.f.	Mean Squares								
		5% Prod.	50% Prod.	Egg Prod.	2 Yr. Wt.	Extra Large	Large	Medium	Small	Peewee ¹
Total	71									
Houses	2	3.88	50	11,705	0.95	.00414	.00084	.00108	.00001	.000740
Trials	1	0.50	57	9,823	0.21	1.38570	1.23320	.00413	.00001	.004981
Error a	2	132.12	124	1,532	0.06	.00595	.00096	.00117	.00004	.009734
Strains	5	99.10	111	1,664	0.19	.00664*	.00442**	.00046*	.00002	.013624
Treatments	1	26,526.72**	8,800**	2,850	0.21	.02204*	.00005	.01064**	.00086**	.728073**
Strains X Houses	10	12.18	8	553	0.05	.00123	.00083	.00007	.000002	.001606
Strains X Treatments	5	93.76	86	1,258	0.03	.00080	.00022	.00012	.00003	.017028*
House X Treatments	2	2.26	20	68	0.06	.00179	.00027	.00052	.00001	.003009
Strain X House X Treatments	10	12.60	20	185	0.02	.00065	.00037	.00009	.000003	.001933
Error b	33	38.55	46	862	0.06	.00171	.00091	.00018	.00007	.006424

*Significant at 0.05% level of probability.

**Significant at 0.01% level of probability.

¹Mean squares for pee-wee multiplied by 1000.

significant for medium; whereas, the difference between treatments was highly significant for extra large, large, small and peewee. The only significant interaction was between strains and treatments for peewee eggs; however, none of the six strains that were restricted laid more than 37 peewee eggs while the six full fed strains laid from 186 to 484 peewee eggs.

The significant interaction between strains and treatments resulted from the fact that the full fed strain that laid the smallest number of peewee (186) was the restricted strain that laid the most peewee (37). The full fed birds laid approximately 20 times as many peewee in Trial 1 and 10 times as many in Trial 2 as the restricted fed group and the full fed laid almost 4 times as many small eggs as the restricted fed group.

Cost and Feed-Egg Ratio

The pounds of feed required to produce a dozen eggs was slightly less for the full fed group in both trials. Strain 2, Trial 1 had the lowest requirement (4.47) while Strain 1, Trial 2 had the highest requirement (6.17). The birds in the cages required less feed to produce a dozen eggs than either floor unit (Table 6).

The higher mortality in the restricted fed group is reflected in the higher chick cost; however, this higher chick cost is offset by the lower feed cost to 26 weeks of age.

The cost for chick, feed, brooding and

vaccination to 26 weeks of age was \$1.3 per bird for the full fed group and \$1.1 per bird for the restricted fed group.

The labor income was higher for the restricted fed birds in both trials. The mean labor income per bird was \$4.1 for the full fed group and \$4.65 for the restricted fed group (Table 8).

Table 8. Cost and income per 100 birds (based on number alive at 26 weeks of age).

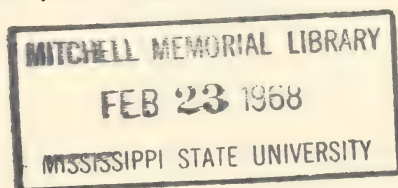
	Trial	Full fed	Restricted fed
Chick Cost	1	\$ 37.89	\$ 37.99
	2	37.63	40.40
	Mean	37.76	39.20
Feed cost to	1	99.63	74.59
26 weeks of age	2	90.45	68.32
	Mean	95.04	71.45
Cost to 26	1	141.51	116.58
weeks of age*	2	132.08	112.72
	Mean	136.80	114.65
Cost of laying	1	414.93	441.36
mash	2	443.96	460.28
	Mean	429.44	450.82
Total Cost	1	556.44	557.94
	2	576.04	573.00
	Mean	566.24	565.47
Income from	1	1006.00	1032.50
eggs	2	884.00	964.00
	Mean	945.00	998.25
Income from sale	1	33.94	33.88
of old hens	3	30.45	30.15
	Mean	32.20	32.01
Total Income	1	1039.94	1066.38
	2	914.45	994.15
	Mean	977.20	1030.26
Labor Income	1	483.50	508.44
	2	338.41	421.15
	Mean	410.96	464.79

*\$0.04 per bird added for brooding and vaccination.

Once-Over Harvesting and Processing Studies with Certain Vegetable Crops



Figure 1. A pea and bean combine (portable viner) picking up windrowed lima beans and shelling them in the field. This machine will also harvest English peas and Southern peas in like manner.



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ONCE-OVER HARVEST AND PROCESSING STUDIES WITH CERTAIN VEGETABLE CROPS

By JOHN A. CAMPBELL, STEVE L. WINDHAM, and W. O. THOMAS*

The need for mechanizing vegetable production and harvesting operation has greatly increased during the past 5 years. This has intensified the need for new information on cultural practices, varieties adapted to machine once-over harvest and processing qualities in the processing plant.

Total and early yields become obsolete terms for most crops under such conditions. When and how can maximum yields of acceptable produce be obtained in a single harvesting operation by a mechanized harvester, is the point of first consideration.

Land preparation, fertilization, herbicide application, planting, cultivation, irrigation and harvesting must be accomplished in such a manner as to maximize profitable once-over or "destructive" harvested yields.

Just how well crops and crop varieties are adapted to these practices often determine the feasibility of producing a particular crop. The crop or variety must be delivered to the plant in a condition that will provide maximum recovery of the raw product in the processed pack-out of high quality.

At the Truck Crops Branch Station, many of the questions have been studied. The data presented herein are indications as to what could be expected when crops as English peas, Southern peas, lima beans, turnip greens, broccoli, snap beans and sweet potatoes are grown and mechanically harvested for processing.

English Peas

English peas were grown in south central Mississippi for half a century as a fresh market crop for shipping. However, as the consumption of fresh peas has declined to almost nothing so has production for fresh market which has,

for all practical purposes, been replaced by the frozen product.

In 1962, with the establishment of the pilot processing plant at the Truck Crops Branch Station, a program of testing freezer type varieties was begun. Land was prepared flat and fertilized broadcast with 100 lbs. N, 120 lbs. P_2O_5 , and 100 lbs. K_2O . Beds 50" wide were formed and pea seed planted at the rate of 120 pounds seed per acre, in four drills 11 inches apart from January 20th to February 10th, depending on weather conditions.

No herbicide was used due to the unfavorable temperature for grass or weed growth. No cultivation was performed. The crop was irrigated usually not more than twice depending on frequency of rainfall to produce good yields as well as quality. Insecticide was applied to control aphids only when they appeared which ranged from one to two applications of the recommended treatment.

Once-over harvest was made when the first pods began to turn a gray color. Harvest dates were effectively estimated by using a combination of heat unit accumulation and number of days to maturity.

Table 1 gives the average yields for the periods indicated. The pods, which had been stripped from the vines, were shelled in a pilot commercial type sheller where percent shell out and yield of shelled peas were determined. The peas were then processed using commercial procedure on a pilot scale and frozen in a plate type freezer at $-30^{\circ}F$. which accurately indicated the degree of recovery of the raw product per acre. All varieties scored A grade.

*Staff members, Truck Crops Branch Experiment Station, Crystal Springs, Miss.

It will be noted that with the varieties tested, a two-week harvest period was possible from the earliest to the latest maturing lines when all were planted the same date. The harvest could be extended for any one variety to three or four weeks by successive plantings starting in southernmost Mississippi and ending with the last planting in northernmost Mississippi. April 25 to May 1 should be considered the latest date for harvest in south central Mississippi due to increase in temperature, which lowers the quality.

Yields of all varieties were about equal to the national average for freezing. Coronet and Freezer 626 were the highest producers with 3260 and 3113 pounds shelled peas per acre respectively. The recovery in the processed pack-out was considered excellent for all varieties.

Lima Beans

Variety trials for once-over harvest and freezing studies have been conducted for the past six years to determine if profitable yields of satisfactory quality can be produced for processing under Mississippi conditions.

The varieties indicated in Table 2 were planted April 20 to May 10 when soil had warmed to a favorable temperature for good germination. Fertilizer was ap-

plied at the rate of 60 lbs. N, 80 lbs. P_2O_5 , and 80 lbs. K_2O . Seed were planted on 42-inch rows in two drills 11 inches apart at the rate of 80 pounds per acre. Treflan was incorporated in the soil before planting to control grass and weeds. Two applications of fungicide and insecticide were applied to control stem anthracnose and insects.

A once-over harvest was made each year when the first set pods began to turn a yellow color. All pods that were mature enough to shell were picked from the plants and shelled in a commercial type sheller in the pilot processing plant. The shelled beans were then processed using standard procedures, packaged in 12 oz. cartons and frozen in a plate type freezer at $-30^{\circ}F$. Yields of shelled beans per acre and pounds recovered in the processed pack-out for each variety are shown in Table 2.

Dixie Butterpea (Speckle) was the highest yielder. Jackson Wonder, a small-seeded speckled lima was second highest. Early Thorogreen produced the highest six-year average yield of the green seeded varieties. These yields are equal to the national average for freezing.

Response to plant nutrients is much more pronounced for lima beans than for Southern peas or snap beans. Even

Table 1. Once-over English pea yield trials for freezer processing and recovery in plant.

Variety	Harvest date 1967	Four-year average	
		Lbs. shelled peas/acre	Lbs. recovery or pack-out in processing plant,
Sprite	4-11	2409*	2240*
Freezer 69	4-18	2499	2328
Coronet	4-19	3260*	3280*
Signet	4-19	2045**	1905**
Pluperfect	4-21	2688**	2528**
Freezer 640	4-24	2500	2339
Freezer 626	4-24	3113	2834
*One Year only 1967			
**Three year average			

on soils where available levels of P and/or K are high, yield responses are measured for certain treatments. Data presented in Table 3 represents the summary of four locations for two years.¹ Variety used was green seeded Henderson Bush. These results show that all treatments increase yields over that harvested for the check. The highest yields were recorded for plots receiving 60 lbs. N, 80 lbs. P₂O₅ and 80 lbs. K₂O. This treatment should be used for maximum yields unless soil analyses are made.

Southern Peas

Southern pea variety trials have been conducted at the Truck Crops Branch

Station for several seasons. In cooperation with the "Southern Regional Southern Pea Variety Trials," many varieties and advanced breeding lines have been grown and studied for their once-over yielding and freezing qualities. Recommended cultural practices for pea production were carried out in these studies. Peas were hand harvested when the first set pods were slightly over-mature, the entire crop being harvested at one time. The peas were machine shelled and processed in the pilot processing plant and frozen in 12 oz. cartons in a plate type freezer at -30°F.

¹Complete results to be reported at a later date.

Table 2. Once-over bush lima bean yield trials for freezer processing and recovery in plant.

Variety	Harvest date 1967	Six-year average	
		Lbs. shelled peas/acre	Lbs. recovery or pack-out in Processing plant
Jackson Wonder (Speckle)	7-19	2323	2403
Early Thorogreen	7-20	2011	2154
Clarks Bush	-	1908*	1835*
Thaxter	7-24	1748*	1698*
Nemagreen	7-24	2068***	2129***
Dixie Butterpea (White)	7-24	2252**	2133**
Dixie Butterpea (Speckle)	7-20	2564*	2700*
*Five Year Average			
**Four Year Average			
***One Year only 1967			

Table 3. Influence of certain fertilizer application on yields of lima beans.

Treatment	Once-over harvest (Lbs. per Acre)			
	Shelled Beans		Frozen Product	
Lbs./Acre N P ₂ O ₅ K ₂ O	1966	2-yr. Avg 1965-66	1966	2-Yr. Avg. 1965-66
0-0-0	1426	1488	1340	1399
20-20-20	1736	1612	1631	1515
40-40-40	1798	1612	1690	1515
60-80-80	1984	1736	1864	1632
80-80-80	1798	1550	1690	1457
80-120-120	1922*	-	1807*	-
*One year's results only				



Figure 2. Harvesting semi-dry Southern peas for canning with a grain combine. These peas will run about 25 percent moisture content.

The three varieties given in Table 4 are well adapted to local growing conditions and produced satisfactory yields. The variety, Bunch Purple Hull a Purple Hull Pink Eye type, is presently being used by freezers and canners. Under the conditions of this test, this variety will produce approximately 1500 pounds of shelled peas per acre.

The frozen product makes a very attractive pack. The peas retain a distinctive pink eye pattern and the seed coat blanches green to pearl in color, depending on stage of maturity. Mississippi Silver, a crowder type, has a concentrated pod set and maturity. This variety produced the highest yield with the highest percent shell out as shown

in Table 4. This variety can be grown and processed in areas where brown crowder peas are desired. The seed coat blanches from light green to brown.

Dixie Lee produces moderate yields under local growing conditions. This variety yielded approximately 1400 pounds of shelled peas per acre. The seed coat of this variety blanches from light green to brown.

Earlier results had indicated that Southern peas could be grown profitable for processing on fertile soil with a level of organic matter sufficient to retain moisture and at the same time have both good surfaces and internal drainage. Results shown in Table 5 were ob-

Table 4. Southern pea variety trials, once-over harvest.

Variety	Two-year averages 1965-66	
	Calculated lbs. shelled peas/acre	Percent shell out
Bunch Purple Hull	1589	48
Mississippi Silver	2272	56
Dixie Lee	1404	52

Table 5. Fertilizer and cultural studies: Southern peas. (Purple Hull Bunch)

Treatment	Once-over harvest per acre	
	Lbs. shelled peas	Lbs. Frozen peas
Single row	1372	1235
Twin row	1563	1529
Single row + 100 lb. superphosphate	1531	1500
Single row + 200 lb. superphosphate	1860	1860
Twin row + 200 lb. superphosphate	1426	1412

tained from such a soil. Phosphorus levels were high, potassium medium, pH 6.0 and an organic matter 1.50 percent.

These results show that under the conditions of this test, peas of the purple hull bunch variety when sown at rate of 20 pounds per acre on 42-inch rows produced 1372 pounds of shelled peas. This was obtained with no fertilizer application. Adding superphosphate in the drill at the time of planting increased yields to as high as 1860 pounds per acre. The higher yields of both green peas and the frozen product for the phosphorus treatments is thought to be due to a more uniform maturity for these treatments.

Broccoli

A study was made to determine the effect of plant population and degree of maturity at time of cutting on total yield of broccoli from a once-over harvest.

The variety Coastal was directly seeded in a single drill on 42-inch rows in mid-August. The plots had been fertilized with 600 pounds of 10-20-20 per acre. When the plants were about four inches

tall they were thinned at three rates: single plants 10 inches apart, two plants per foot, and four plants per foot.

One half of the plots was harvested when 80 to 90 percent of the terminal heads were mature, and the other half when 10 to 15 percent of the heads were over mature. Both harvests were made in a once-over operation by hand cutting in order to simulate the results of machine harvesting. Only the terminal heads were harvested. Results of the studies are given in Table 6.

A delay in harvest until 10 to 15 percent of the heads were over-mature about doubled the yield in all three plants populations over the harvest where 80 to 90 percent of the heads were mature. Of course, the over-mature heads (small florets beginning to open) were graded out and were not included in the yield weights. It was apparent that by allowing 10 to 15 percent of the plants to become over mature a much greater number of later maturing plants developed heads ready for harvest, thus accounting for the increase in yield.

Table 6. The effects of spacing, stage of maturity and once-over harvest on yield of broccoli,

Variety Coastal, 2-yr. avg.

Plant population Per acre	Calculated yield -Tons per acre -1965-66	
	80-90 percent mature -Nov. 8-17 Trimmed terminal buds*	10-15 percent Over-mature-Nov.18-23
Approx. 10 in. row		
16215 plants per acre	1.37	2.45
Approx. 2 plants per ft.		
22365 plants per acre	1.52	2.46
Approx. 4 plants per acre	1.36	2.44
41400 plants per acre		

*In these studies, terminal buds trimmed out approximately 80% for freezing.

Table 7. Influence of Fertilizer Application on yield of turnip greens.

Treatment lbs./acre N P ₂ O ₅ K ₂ O	Tons per acre	
	Fresh	Frozen
0-0-0	5.0	3.0
40-0-0	5.5	3.5
40-40-40	5.6	3.5
20-20-20	5.1	3.2
40-40-40 (plus N topdressing)	5.0	3.0
30 lbs. N as topdressing	4.4	2.9

Yields were about the same for the different plant populations. The trimmed broccoli was processed in the pilot processing plant and frozen in 10 oz. cartons in a plate type freezer at -30°F . Approximately 80 percent of the raw product was recovered in the processed form.

Turnip Greens

In addition to variety, disease and insect control, soil type, soil temperature, rainfall and level of available nutrients all determine the fertilizer requirements for this crop. Only two varieties have been grown in detail tests, Shogoin and Purple Top. The quickness of Shogoin to bolt is definitely a distinct disadvantage for this variety. Since harvesting is expected to occur 6 to 8 weeks after seeding, fertilizer applications should be made at the time of seeding or soon hereafter. Plants were grown in three rows, 12 inches apart on 42 inch beds.

The data presented in Table 7 was harvested from plots grown on a soil with a high plus P and medium plus K and pH of 6.0. As shown by these results 40 lbs. of N alone at the time of seeding was equal to any other treatment both from a fresh weight and percent turn out of the frozen product. However, this would only be true where greens are grown under the conditions of this test.

When night temperatures are lower than $40-50^{\circ}\text{F}$., yields on the same soil will be significantly greater when 40 lbs. N, 40 lbs. of P₂O₅ and 40 lbs. of K₂O per acre are added at the time of planting. With excessive rainfall, extra nitrogen may be needed and can be applied as a topdressing.

The relatively low fresh yields are explained in part by the percent turnout of frozen products. The plants were cut to leave most of the stem in the field



Figure 3. Snap beans being harvested by two-row picker. Specially adapted varieties are needed to produce a profitable once-over yield of high quality pods. The clean picked pods are conveyed into the dump box trailing in the rear as shown.

and give a fancy processed product.

Machine Harvesting

All crops discussed here, including bush snap beans, require mechanical harvesting to be profitable for processing. The cost of the particular machine is an important factor in determining the acreage of the crop to be planted in order to be economically feasible.

Figure 1 shows a pea and bean combine in operation. This machine, after the plants have been cut and wind-rowed, lifts and conveys the plants with pods into the machine which shells the peas or lima beans and discharges the hulls and vines on to the land. The pea and bean combine will harvest English peas, Southern peas, and lima beans in the green stage for freezing or canning.

Southern peas can be harvested with a grain combine for canning only. This is done by letting the peas dry to about 25 percent moisture content. Using this

method would, of course, reduce the yield in terms of pounds per acre.

Snap beans are harvested with a two-row picker. This machine does an excellent job of picking and cleaning the beans in a once-over operation. Once-over yield trials for this crop have been reported in the September issue of this publication.

All greens crops (turnips, mustard, kale, collards, and possibly broccoli) can be harvested with a greens harvester which has a mower type cutter bar and a conveyor to transfer the crop to a trailer or truck. These crops must be planted on row widths suitable for the harvester.

Data presented in Table 8 shows the cost of production, the expected yield, and net profit for vegetables grown for onceover harvesting in Copiah County. Although these data may not fit every

location in the state, they certainly may be used as guide lines where vegetables are grown.

As shown in these results, highest total income of \$171.28 per acre was for lima beans. The lowest net return was for English peas. Turnip greens and snap beans occupied the land the shortest

length of time whereas English peas and broccoli required the most time from seeding to harvest.

Regardless of crop, the data presented here shows a reasonable return when these crops are grown according to recommended practices and for once-over mechanical harvest.

Table 8. Budget Guide Lines for Certain Vegetables Crops when grown and harvested with Two-Row Equipment.¹

Crop	Specified Cost			Yield/ acre(tons)	Gross Returns	Net profit	Days to harvest
	Materials ² /	labor	equip. ³ /				
Broccoli	55.80	16.59	59.87	2.00	250.00	117.74	120
English Peas	61.60	3.91	39.30	1.50*	150.00	45.19	95
Lima Beans	68.78	6.94	53.00	1.25*	300.00	171.28	65
Snap Beans	65.88	6.94	68.00	2.00	190.00	49.18	55
Southern Peas	32.62	6.94	30.00	0.60	144.00	71.44	65
Sweet Potatoes	77.02	38.03	25.18	6.00	240.00	94.77	150
Turnip Greens	49.42	5.05	28.49	5.00	162.50	69.54	50

*Shelled produced

¹ Basis for this data: Experimental results, Truck Crops Exp. Station Budget Guides for Selected Vegetable Enterprises in Miss. A Ec. M.R. No. 40 and Field and Plant Records of Miss. Federated Processing Plant. Detail sheets for 1, 2 and 4 row operations are available at Truck Crops Branch Station.

² Includes fertilizer, seed, fungicides, insecticides, herbicides, etc.

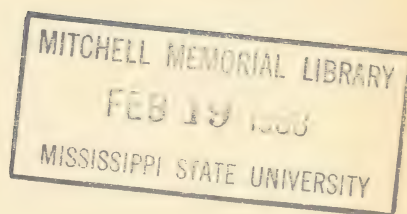
³ Includes rental for harvesting.





Factors Affecting The Incidence of Blood Spots In Eggs

ELBERT J. DAY, BEN C. DILWORTH
and O. W. CHARLES



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HENRY H. LEVECK, Director

Summary and Conclusion

The incidence of egg blood spots in eggs was altered (decreased and increased) by modifying the diet of cage layers.

Addition of alfalfa meal (a rich source of vitamin K) or MSBC (synthetic vitamin K) to the diet tended to increase the number of eggs containing blood; while, addition of anti-vitamin K compounds decreased the incidence of egg blood spots.

Within a short range in blood prothrombin time, there appears to be an inverse relationship between egg blood spotting and prothrombin time. More research work is needed to determine the exact cause of egg blood spots and to find ways to prevent their occurrence.

FACTORS AFFECTING THE INCIDENCE OF BLOOD SPOTS IN EGGS

ELBERT J. DAY, BEN C. DILWORTH and O. W. CHARLES

Blood spots in eggs result in a great economic loss to the poultry industry. It has been estimated that from 1 to 3% of all commercial eggs are discarded because they contain blood spots. An additional 1-3% of the eggs passing the candling inspection contain very small, pin-point spots too small to be detected by the candling procedure. Such eggs undoubtedly reduce per capita consumption because of the unfavorable impression they create.

Blood spots are thought to be caused by hemorrhages in the follicles of the hen's ovary. These ruptures are thought to occur prior to ovulation, during ovulation and following ovulation. The basic cause of the hemorrhages is not known. It would be logical to assume that factors which affect capillary fragility (vitamin C) or blood clotting (vitamin K) would also influence the incidence of blood spots in eggs.

Early attempts to correct this abnormality centered around these suppositions. Birds were fed fresh young grasses, allowed to range or fed dehydrated alfalfa meal in attempts to reduce the number of eggs containing blood. Due to the favorable reports from feeding grasses and alfalfa meal, vitamins K, E, D, A and C were tested as well as added phosphate and rutin, but all were ineffective.

Recent trials at several experiment stations with added alfalfa meal, a good source of Vitamin K, have also been ineffective in reducing egg blood spots. It is becoming increasingly apparent that vitamin K deficiencies are not responsible for the spots. The addition of synthetic vitamin K active compounds or the addition of feedstuffs high in vitamin K, such as alfalfa meal, usually exert no favorable effect.

Although efforts to reduce the incidence of spots by nutritional feed additives have in general failed, it has been well established that adequate nutritional balance, is important. A dietary deficiency of vitamin A or excess protein has been shown to aggravate egg blood spotting. Management practices or physiological stress is another important factor. For instance, birds housed in raised wire cages lay eggs containing approximately 33% more blood spots than comparable birds maintained on litter floors. Genetic selection has been practiced extensively as a method of spot incidence but it has not been completely successful in eliminating them in eggs.

The trend toward increased numbers of cage layers and the advent of some recent interesting research results have served to increase the research efforts directed toward finding ways to reduce the incidence of blood spots in eggs.

Recent research results which have been of particular interest can be summarized rather briefly: (1) Alfalfa meal, which is known to be the best natural source of vitamin K, has been found by two different research groups (Mississippi and Idaho) to increase blood spots in eggs when added to layer diets and (2) vitamin K antagonists, such as dicumarol, have been found to decrease the incidence of egg blood spotting.

These findings are certainly contrary to what one might logically conclude from our past beliefs about the primary cause of egg blood spots. Since vitamin K is necessary for the biosynthesis of prothrombin, an enzyme essential in the blood clotting process, it was generally

*Staff members, Poultry Science Department, Mississippi Experiment Station.

thought that abundant dietary levels of vitamin K were beneficial, not harmful, to the egg blood spotting problem. Apparently, there is no correlation between the bird's prothrombin time and blood spotting of eggs.

In studies conducted by research workers at the University of Florida and at our station, prolonged prothrombin times, which indicate a slow blood clotting time, have not resulted in an increased number of eggs which blood spots as one might suspect. At our station, vitamin K antagonists have been found to actually reduce the number of eggs containing blood spots, while vitamin K active compounds and alfalfa meal have been found to aggravate this condition. The purpose of this paper is to present some of our findings in this area.

Experimental Procedure

White Leghorn layers were maintained in individual cages and allowed feed and water on a free choice basis. The dietary additives were substituted into corn-soy type basal diets (Table 1). The experimental variables are shown in Tables 2, 3, 4 and 5 along with the results from each study. The incidence and size of blood spots were determined by collecting and breaking all eggs laid during two consecutive days each week. A glass plate mirror device was used which allowed us to view the broken - out eggs

from all angles. Blood prothrombin determinations were made at the end of each test period. Replicate or quadruplicate groups of 17 birds per group were used to evaluate each dietary treatment in all tests.

Results and Discussion

Since egg production and feed utilization were not significantly affected by dietary treatment, these data are not presented for Trial 1. Blood spotting of eggs and blood prothrombin times were affected by the types of diets fed, as shown in Table 2. The single dietary addition of the active vitamin K supplement, menadione sodium bisulfite complex (MSBC), significantly increased the percentage of eggs containing blood spots as compared to the control diet. Alfalfa meal also tended to cause a higher incidence of blood spots, but this increase was not significantly different from the

Table 1. Composition of basal diets.

Ingredient	Percentage	
	Exp. 1	Exp. 2-5
Yellow corn	72.34	70.00
Soy, 50% protein	20.00	21.47
Limestone	4.50	5.00
Defl. phos.		
14% P, 29% Ca	2.50	2.40
Sodium chloride	0.40	0.40
Premix	0.23	0.63 ¹
Poultry fat	...	0.50
TOTAL	100.00	100.00

¹Contributes 0.025% DL-methionine in addition to vitamins and trace minerals.

Table 2. Effect of supplemental menadione sodium bisulfite complex, (MSBC) alfalfa meal and dried whey on the incidence of blood spots in eggs and blood prothrombin time of layers, Experiment 1.

Diet	Number of eggs broken	Number of blood spots	Blood spots, %	Blood prothrombin time, sec.
Basal	1985	80	4.0 a ¹	46.0 a ¹
+ MSBC, 4 g./ton	1968	136	6.9 b	34.2 bc
+ 17% alfalfa, 2.5%	1874	96	5.1 ab	36.9 bc
+ 17% alf., 2.5% + MSBC		96	5.3 ab	34.6 bc
+ whey, F.M. and alfalfa	1882	98	5.2 ab	41.4 ab
+ whey, F. M., alf. & MSBC	1983	107	5.4 ab	33.4 c

¹Averages within a column and without a common letter designation are significantly different at the 5% level of probability.

average percentage blood spots of eggs from hens fed the basal diet.

The average blood prothrombin time for the birds fed the simplified corn-soy basal ration was significantly lower than that of the other groups. These data suggest that a rise in blood Prothrombin time may be beneficial, rather than harmful, in preventing blood spotting of eggs.

The second test (Table 3) was designed primarily to determine whether or not there was a correlation between egg blood spotting and blood prothrombin of layers. Dicumarol was added to the diet to prolong prothrombin time and MSBC was added to reduce the prothrombin time.

Dicumarol significantly reduced the Percentage of eggs containing blood spots. In addition, blood prothrombin time was significantly increased by feed

ing dicumarol. The single dietary additions of MSBC or sulfaquinoxaline (SQ) had no significant effect on blood prothrombin time or egg blood spotting. Both additives tended to increase the number of eggs with blood spots.

The addition of both MSBC and SQ to the basal caused a significant change in egg blood spot incidence without significantly affecting prothrombin time. SQ was the only additive which significantly reduced egg production and/or feed utilization. As would be expected, the addition of MSBC to the diet decreased the adverse effect of SQ on performance.

Experiment 3 was conducted primarily to determine the relative potency of several available vitamin K antagonists. We believed that it was imperative for us to find a compound more potent and cheaper than dicumarol. Such a compound was available as can be seen from the

Table 3. The effect of menadiione sodium bisulfite complex (MSBC) dicumarol and sulfaquinoxaline (SQ) on the incidence of egg blood spots and blood prothrombin time of cage layers, Experiment 2.

Dietary treatment ²	Results, 3 months ¹			
	Egg blood spots, %	Prothrombin time, sec.	Hen-day prod., %	Lbs. feed doz. eggs
Basal	4.78 a	29.2 ab	68.8 a	4.59 a
Basal plus MSBC	5.89 a	28.9 ab	58.2 a	4.56 a
Basal plus dicumarol	1.58 b	53.5 c	66.2 a	4.73 ab
Basal plus SQ	5.37 a	35.1 b	50.8 b	5.27 b
Basal plus SQ and MSBC	9.02 c	27.9 a	52.4 b	5.12 ab

¹See footnote 1, Table 1.

²Additive levels were: dicumarol, 100 mg./lb.; SQ, 56.5 mg./lb., and MSBC, 2 mg./lb. (SQ was fed at 113.0 mg./lb. during the first month).

Table 4. A comparison of the anti-vitamin K activity of different compounds, Experiment 3.

Dietary modification		Two month results ¹		
		Prothrombin time, sec.	Total eggs	Blood spots %
Additive	Mg./lb.			
Basal		27.3 a	313	4.90 a
+ Dicumarol	100.00	38.3 a	360	1.58 a
+ Dicumarol	50.00	39.5 a	357	2.00 a
+ Dicumarol	12.50	31.8 a	305	1.55 a
+ Dicumarol	3.12	29.7 a	313	6.24 a
+ Dicumarol	1.56	31.1 a	364	2.48 a
+ Diphacinone	12.50	64.6 b	294	3.56 a
+ Pivalyl	12.50	84.1 b	326	2.12 a
+ Fumarin-22 ²	12.50	31.2 a	393	2.42 a

¹See footnote 1, Table 1.

²The basal diet was substituted for the Fumarin-22 ration five days prior to the blood sampling.

data presented in Table 4. Pivalyl and diphacinone, two indandione derivations, are much more potent than dicumarol. Critical chick bioassays at our laboratory have shown that pivalyl and diphacinone are 20 and 15 times, respectively, more potent vitamin K antagonists than dicumarol. Since pivalyl costs less and is more potent than the other compounds it was used along with dicumarol in subsequent layer tests.

Results from the fourth experiment are quite typical of most of the previous data obtained at our station (Table 5). Both alfalfa meal and MSBC tended to increase the incidence of blood spots in eggs. The percentage blood spots in eggs from hens fed pivalyl (5 mg./lb.) was significantly reduced as compared to eggs from hens fed MSBC (2 mg./lb.). The percentage blood spots also tended to be less from hens fed either pivalyl at the higher dietary level (10 mg./lb.) or dicumarol (100 mg./lb.). Feeding the highest dietary level of pivalyl (10 mg./lb.) resulted in an extremely long prothrombin time, but was not more beneficial in reducing egg blood spots than the lower dietary level (5 mg./lb.).

In the final experiment to be reported in this paper, an attempt was made to further increase the incidence of egg

blood spotting by adding a very high dietary level of MSBC (20 mg./lb.) and also determine whether or not a very low dietary level of pivalyl (0.5 mg./lb.) would reduce egg blood spotting.

Results from the last experiment are presented in Table 6. These data are somewhat different from the previous results because supplemental alfalfa meal (5%) and MSBC did not aggravate the egg blood spot problem. The data from this experiment are similar in one respect to the previous results since the highest level of pivalyl again significantly reduced the percentage of eggs containing blood. The failure of added alfalfa meal and MSBC to aggravate the egg blood spot problem in this test could be related to the blood prothrombin time of the birds. Usually the birds fed the corn-soy basal ration have exhibited an

Table 5. The effect of diet on prothrombin time and incidence of blood spots, Experiment 4.

Dietary modifications	Prothrombin time, sec. ¹	% blood spots ¹
Basal	33.1 a	4.2 ab
+ Alfalfa, 2.5%	30.0 a	5.1 ab
+ MSBC, 2 mg./lb.	29.4 a	6.6 a
+ Dicumarol, 100 mg./lb.	66.8 b	2.1 ab
+ Pivalyl, 5 mg./lb.	63.6 b	1.6 b
+ Pivalyl, 10 mg./lb.	133.4c	2.3 ab

¹See footnote 1, Table 1.

Table 6. Effect of dietary modifications on performance, prothrombin time and egg blood spotting, Experiment 5.

Dietary modifications	Lay	Lbs. feed/ doz. eggs	Results, 9 months ¹		Prothrombin time, sec.	% blood spots
			% Mort.			
Basal	63.5 a ¹	4.6 b ¹	9.6		20.8 a ¹	4.8 a ¹
+ 17% Alfalfa (5%)	56.1 b	5.0 a	8.0		20.4 a	4.5 a
+ MSBC (2 mg./lb.)	65.7 a	4.4 bc	8.0		19.5 a	4.0 a
+ MSBC (20 mg./lb.)	63.4 a	4.5 b	14.4		18.6 a	4.0 a
+ Pivalyl (5 mg./lb.)	66.4 a	4.2 c	6.4		22.1 a	5.1 a
+ Pivalyl (5 mg./lb.)	66.6 a	4.5 b	17.6		31.1 b	1.3 b

¹See footnote 1, Table 1.

average blood prothrombin time of 27-33 seconds, but in the last test, prothrombin time for the control birds was 20.8 seconds. We have no explanation for this difference in prothrombin time of the control birds at present. The experimental procedure of determining blood prothrombin time was held constant for all tests, but it is highly likely that there is some variation in the vitamin K content of the ingredients used in the basal ration from experiment to experiment. Also, differences in intestinal synthesis of vitamin K could account for variation in the prothrombin time of the birds fed the basal diet.

These data suggest that if there is an inverse relationship between egg blood spotting and blood prothrombin time, this relationship extends only for a short range in prothrombin time. Severe pro-

longation of the prothrombin time was no more beneficial in reducing egg blood spotting than a more moderate level. Also, high dietary levels of added MSBC do not appear to be any more detrimental than low levels of added MSBC.

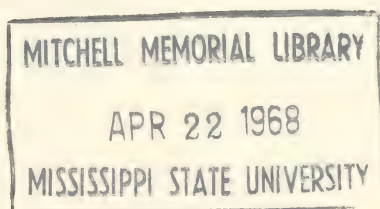
Except during the first experiment, all egg blood spots were recorded according to size and a percentage distribution table was made for each experiment as is indicated in Table 7 for the last experiment. It is apparent from these data, which are representative of the results from the other experiments, that the additive did not materially affect the size distribution pattern of the blood spots. We had assumed that the anti-vitamin K compounds might be effectively reducing the number of egg blood spots detected by hastening disolution, especially the pin-point size blood spots.

Table 7. The effect of diet on the size of egg blood spots, Experiment 5.

Diet	Egg blood spots, %			Bloody
	Pin-point	-1/8"	+1/8"	
Basal	32.8	25.0	39.0	3.2
+ 17% alfalfa (5%)	41.2	21.8	35.4	1.6
+ MSBC (2 mg./lb.)	22.6	34.7	42.7	0.0
+ MSBC (20 mg./lb.)	34.6	26.6	37.8	1.0
+ Pivalyl (.5 mg./lb.)	35.9	19.6	41.5	3.0
+ Pivalyl (5 mg./lb.)	38.3	21.7	40.0	0.0

Effects Of Growth Regulators On Germinating Cotton

By G. E. COATS



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STATE COLLEGE

MISSISSIPPI

Table 1. Treatments used in field study.

Treatment No.	Common name or abbreviation	Chemical structure
1	IAA	3-indole acetic acid
2	Gibrel	gibberlic acid
3	Kinetin	6-fuylfrulamino purine
4	NAA	1-naphthyleneacetic acid
5	MeNAA	2-methyl-1-naphthylene acetic acid
6	NAAM	1-naphthyleneacetamide
7	MeNAAM	2-methyl-naphthyleneacetamide
8	Napthoxy	beta naphthoxy acetic acid
9	NaMeAct	alpha naphthyl methyl acetate
10	Succinic acid	Succinic acid
11	TD-692	Pennsalt designation, chemistry confidential
12	TD-693	Pennsalt designation, chemistry confidential
13	TD-6056	Pennsalt designation, chemistry confidential
14	TD-6058	Pennsalt designation, chemistry confidential
15	Omaflora	beta hydroxyethyl hydrazine
16	Alar	N-dimethyl amino succinamic acid
17	Hadacidin	N-hydroxy-N-formyl sodium glycinate
18	Duraset	N-m-tolylphthalamic acid
19	IBA	indole butyric acid
20	MeMe	1-naphthylmethyl methyl ether
21	Butoxy	Buthoxy ethyl ester of NAA
22	MH	maleic acid hydrazide
23	TIBA	2,2,5-triiodo benzoic acid
24	Tetra CBA	2,3,5,6-tetrachloro-benzoic acid
25	Mendock	sodium alpha-beta-dichloroisobutyrate

EFFECTS OF GROWTH REGULATORS ON GERMINATING COTTON

By G. E. COATS¹

The following report gives the results of a screening program at Stoneville on the effects of various growth regulators on germinating cotton. Studies were primarily limited to laboratory studies with follow-up work in the field in spring of 1967 and limited studies in controlled environment chambers.

Effects of growth regulators on germinating seed were studied using the bioassay for vigor described by Christensen². In each study 25 seed were placed on germinating paper with the radicle end of the seed aligned in one direction. Each germination roll was wet with water or a water solution containing growth regulators. Rolls were placed in a rack in an upright position in the germinator at constant 68 degrees F for 7 days.

After 7 days 5 seedlings were removed from each roll, the cotyledons separated from the root-hypocotyl, and the dry weight of each determined; and subsequently, the conversion of cotyledonary reserves to the root hypocotyl was determined. This percent conversion was used as the measure of seedlings growth.

Each test in this study was a randomized block with treatments of 0, 0.01, 0.1, 1.0, 10.0 and 100.0 ppm and 5 replications. Each test was conducted at least twice. Growth regulators through 18 listed in Table 1 were included in this study.

Field studies conducted in the spring of 1967 included the growth regulators used above, plus those listed in Table

1 including combinations of 3 of these growth regulators. Seed were treated in the laboratory in quantities of 100 grams as seed overcoat.

Growth regulators at 2 rates (0.005 and 0.05 oz cwt) were combined with 10 oz cwt of 65% 1,4-dichloro-2,5-dimethoxybenzene (Demosan) and 2 pt. cwt 2.89% methylmercury 2,3-dihydroxy propyl mercaptide and .62% methylmercury acetate (Ceresan L).

On April 13 seed were planted at Stoneville using a belt planter with 100 seed per 34 row feet. Di-Syston (10% formulation o-o-dimethyl S-2 (ethylthio) ethyl phosphorodi thioate) was applied through the hill-drop unit (20-inch hills) at the rate of 4.2 pounds per acre. Stand counts were made the last week in May and the first week in June.

Growth regulators which had shown possible stimulation under germinator conditions were used in growth chamber studies at 0.005 and 0.05 oz cwt. These included Duraset, Gibrel, and MeNAAm. The 4 growth regulators appearing in the Pennington Green Coat seed treatment were also included in this study. Five seed were planted in cups in Bosket sandy loam soil.

Plants remained in the growth chamber for 7-10 days after emergence and then were moved to the greenhouse for an additional week. At this time dry weight of above ground parts of plants was determined. Conditions in the chamber were set at 80% relative humidity, 76° F day temperature and 65° F night temperature with a 16-hour day.

The response of germinating cotton to growth regulators varied from possible stimulation to no apparent effect to inhibition of growth. In most cases, treat-

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²Crop Science 3:487-489.

Table 2. The effect of several natural and synthetic growth regulating compounds on the germination and vigor of germinating Stoneville 213 cotton.

Growth regulator	Treatment	% Germination	Root-hypocotyl		
			Dry wt-mg	Length-cm	% Total
JAA	0	84	257.8 a*	6.3 ab*	23.6 ab*
	0.01	84	259.8 a	7.1 a	25.4 a
	0.1	80	248.2 a	6.7 ab	23.7 ab
	1.0	75	221.8 ab	5.9 ab	22.4 b
	10.0	84	253.6 a	5.6 b	23.0 ab
	100.0	80	189.8 b	2.1 c	17.5 c
Gibrel	0	96	391.2	9.9 ab*	32.4 a*
	0.01	96	405.4	9.4 a	34.1 ab
	0.1	94	407.0	9.5 a	33.5 ab
	1.0	95	410.8	10.5 ab	34.5 ab
	10.0	98	414.8	11.1	35.4 b
	100.0	96	407.6	9.6 ab	35.3 b
Kinetin	0	99	348.2 ab*	7.4 ab*	28.6 ab*
	0.01	98	370.2 a	8.0 a	29.6 a
	0.1	96	349.2 ab	7.6 b	28.4 ab
	1.0	99	329.0 bc	7.1 b	27.1 bc
	10.0	97	306.6 cd	6.0 c	25.2 cd
	100.0	93	274.4 d	4.6 d	24.1 d
NAA	0	75	166.8 a*	2.82 a*	15.4 ab*
	0.01	75	173.6 a	3.00 a	16.7 a
	0.1	80	142.0 a	2.76 ab	14.5 ab
	1.0	80	143.4 a	2.06 b	14.9 ab
	10.0	75	130.8 ab	1.30 c	12.7 bc
	100.0	65	90.6 b	.68 c	10.1 c
MeNAA	0	96	348.6 a*	8.8 a*	30.7 a*
	0.01	98	372.4 b	8.2 a	30.1 a
	0.1	94	366.4 b	8.2 a	30.2 a
	1.0	95	357.6 b	7.7 a	30.0 a
	10.0	98	290.0 c	4.1 b	24.3 b
	100.0	94	249.4 d	2.4 b	21.1 c
MeNa Acetamide	0	98	307.4 a c**	7.7 ab**	25.6 a
	0.01	97	323.8 ab	8.0 a c	27.1 a
	0.1	96	334.4 b	7.9 bc	27.3 a
	1.0	98	328.2 b	8.2 c	27.2 a
	10.0	99	323.2 ab	7.6 b	27.2 a
	100.0	94	293.8 c	5.6 d	24.6 a

See footnotes at end of table

Table 2. The effect of several natural and synthetic growth regulating compounds on the germination and vigor of germinating Stoneville 213 cotton--Continued.

Growth regulator	Treatment	% Germination	Root-hypocotyl		
			Dry wt-mg	Length-cm	% Total
Napthozy acetic	0	94	374.6	10.4 a	31.1 a
	0.01	90	348.4 ab	9.2 a	29.8 a
	0.1	98	368.6 a	10.1 a	30.5 a
	1.0	94	331.8 bc	7.3 b	27.9 a
	10.0	94	316.8 c	4.1 c	27.0 a
	100.0	94	214.0 d	1.2 d	18.3 b
NAAm	0	99	313.0 a***	6.5 a*	26.4 a*
	0.01	99	319.6 a	7.0 a	26.5 a
	0.1	98	305.6 ab	6.4 a	25.4 ab
	1.0	98	301.6 ab	6.6 a	26.6 a
	10.0	100	304.2 ab	6.1 a	24.1 bc
	100.0	99	277.0 b	4.0 a	22.8 c
NAMEAct	0	94	362.8 a	8.6 a	30.0 a
	0.01	98	368.6 a	8.6 a	30.0 a
	0.1	96	358.6 a	7.9 b	29.7 a
	1.0	97	340.2 b	5.8 c	28.1 a
	10.0	98	292.4 c	3.0 d	24.6 b
	100.0	96	128.4 d	0.6 e	10.6 c
Succinic Acid	0	84	271.0	7.7	25.5
	0.01	80	260.0	7.2	24.7
	0.1	76	245.0	6.5	24.7
	1.0	76	245.0	6.6	24.0
	10.0	76	250.0	6.1	24.8
	100.0	80	264.0	6.7	24.4
TD-692	0	96	322.2	8.40 ab*	28.5
	0.01	96	327.0	8.82 a	28.8
	0.1	96	300.8	7.30 bc	27.2
	1.0	96	316.4	8.36 ab	28.9
	10.0	92	326.2	8.38 ab	28.9
	100.0	92	304.0	7.00 c	27.0
TD-693	0	96	240.1	6.5	22.5
	0.01	92	238.2	6.1	21.6
	0.1	96	232.2	5.5	21.5
	1.0	96	244.6	7.2	22.4
	10.0	96	246.4	6.3	22.4
	100.0	92	246.6	5.6	22.3

See footnotes at end of table

Table 2. The effect of several natural and synthetic growth regulating compounds on the germination and vigor of germinating Stoneville 213 cotton--Continued.

Growth regulator	Treatment	% Germination	Dry wt-mg	Root-hypocotyl	
				Length-cm	% Total
TD-6056	0	92	328.0 a**	8.9	23.1
	0.01	92	307.0 b	7.9	28.2
	0.1	96	307.0 b	8.0	28.1
	1.0	92	211.0 ab	8.7	28.4
	10.0	92	297.0 b	8.1	24.8
	100.0	96	312.0 ab	9.0	27.0
TD-6058	0	92	299.4	7.3	25.4
	0.01	96	287.0	7.6	26.0
	0.1	92	287.6	6.7	25.4
	1.0	92	296.6	6.8	25.4
	10.0	96	277.4	7.6	26.4
	100.0	92	281.6	6.8	25.1
Omaflora	0	72	237.0	7.6 ab***	24.3
	0.01	88	259.0	7.1 ab	24.2
	0.1	80	260.0	7.2 ab	24.5
	1.0	80	258.0	6.8 bc	25.6
	10.0	84	282.0	7.8 a	25.6
	100.0	75	239.0	6.2 c	23.2
Alar	0	92	282.6	7.14 a**	25.5
	0.01	96	286.4	7.08 a	25.3
	0.1	92	282.2	7.00 a	25.3
	1.0	96	287.4	7.08 a	25.4
	10.0	96	283.4	7.26 a	25.4
	100.0	92	269.0	5.88 b	23.9
Hadacidin	0	80	235.0	5.4 ab**	23.2
	0.01	80	275.0	7.1 a	25.0
	0.1	80	250.0	6.0 ab	25.5
	1.0	84	257.0	6.3 a	24.4
	10.0	75	260.0	7.0 a	25.9
	100.0	75	221.0	4.2 b	21.3
Duraset	0	89	329.8 a*	7.7 a**	28.1 a**
	0.01	93	339.0 ab	8.1 a	28.1 a
	0.1	95	356.2 ab	9.5 b	30.5 b
	1.0	94	367.4 b	9.4 b	30.3 b
	10.0	92	355.8 ab	8.9 ab	29.7 ab
	100.0	88	334.8 a	7.6 a	28.3 a

*, **, *** Values having a common letter do not differ significantly according to Duncan's Multiple Range Test at the 1% (*), 5%(**), or 10%(***) level.

Table 3. Effect of growth regulators and combinations of growth regulators in combination with Demosan and Ceresan on stand of Stoneville 213 cotton.

Treatment No.	Growth regulator	Rate $\frac{1}{\text{oz-cwt}}$	Stand count
21	Butoxy	0.005	65.6
	Butoxy	0.05	56.8
22	MH	0.005	55.2
	MH	0.05	58.0
10	Succinic Acid	0.005	49.8
	Succinic Acid	0.05	57.8
11	TD-692	0.005	50.4
	TD-692	0.05	56.2
0	Fungicide only	0	50.8
12	TD-693	0.005	51.6
	TD-693	0.05	63.6
13	TD-6056	0.005	54.0
	TD-6056	0.05	59.8
14	TD-6058	0.005	57.8
	TD-6058	0.05	53.4
15	Omaflora	0.005	54.6
	Omaflora	0.05	53.4
16	Alar	0.005	43.8
	Alar	0.05	56.6
0	Fungicide only	0	47.2
17	Hadacidin	0.005	52.6
	Hadacidin	0.05	47.2
23	TIBA	0.005	44.4
	TIBA	0.05	41.2
24	Tetra CBA	0.005	43.0
	Tetra CBA	0.05	41.4
25	Mendock	0.005	44.8
	Mendock	0.05	48.6
19	IBA	0.005	37.4
	IBA	0.05	40.6

LSD .05			13.0
LSD .01			17.2

$\frac{1}{\text{oz}}$ Applies to each chemical where combinations were used.

ments of higher rates tended to inhibit growth. Only one growth regulator, Duraset, under laboratory conditions consistently stimulated growth. Gibrel which has been extensively tested on cotton and a large number of other plants stimulated growth, but not consistently.

The three naturally occurring growth regulators IAA, Gibrel, and Kinetin in

general caused no significant effect at lower rates. However, with the exception of Gibrel, growth as measured by the dry weight of root - hypocotyl, length of the root-hypocotyl, and the percent conversion to the root - hypocotyl tended to be progressively inhibited as concentration increased.

In the field study, there was particu-

Table 4. Effect of growth regulators on early growth of cotton under controlled environmental conditions.

Treatment		% Germination	Dry wt-mg per plant
Chemical	Oz-cwt		
Demosan + Ceresan	0	87	312
Demosan + Ceresan + gibrel	0.005	82	333
Demosan + Ceresan + duraset		85	325
Demosan + Ceresan + MeNAAm		78	307
Demosan + Ceresan + gibrel	0.05	78	298
Demosan + Ceresan + duraset		84	270
Demosan + Ceresan + MeNAAm		78	310
Demosan + Ceresan + NAA + MeNAA + NAAm + IBA	0.005	73	326
Demosan + Ceresan + NAA + MeNAA + NAAm + IBA	0.05	71	315

lar interest in the survival of cotton under early spring weather conditions, especially low temperature. As it turned out, we had probably one of the worst cool and wet springs seen in the Mississippi Delta in the past few years.

Again in this test as in the germinator test, the results indicated no consistent beneficial response of growth regulators including Duraset.

The only significant change in stand counts was a reduction in stands in which combinations of the high rates of Gibrel, Duraset, and MeNAAm were used. It should be pointed out that in the case of double treatment, seed received twice the amount of growth regulator and 3 times as much in combinations of 3. It is also interesting to note that in each case of a reduction, one of the regulators was Gibrel. The combination of Duraset and MeNAAm at the

higher rate did not significantly reduce stand counts.

Growth chamber studies indicated no significant increase in growth from Gibrel, Duraset, MeNAAm or NAA and derivatives plus IBA. In two tests conducted in the growth chamber, data indicated partial reductions in stand of seed treated with NAA + MeNAA + MeNAAm + IBA. These are 4 growth regulators which are included in the Pennington Green Coat seed treatment.

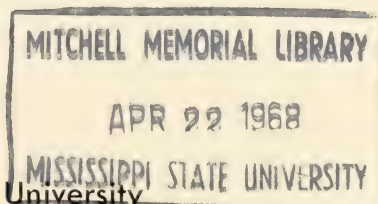
CONCLUSIONS

This study has not revealed any growth regulator which would find practical application under field conditions. It should be pointed out that response similar to Duraset is applicable only under the specific conditions under which tests of this kind are conducted.

Factors Related to Use of Recommended Forestry Practices In Five Mississippi Counties

By

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MISSISSIPPI



FACTORS RELATED TO USE OF RECOMMENDED FORESTRY PRACTICES IN FIVE MISSISSIPPI COUNTIES

By CARLTON R. SOLLIE

Introduction

The United States Forest Service reported in 1958 that more than 52 percent of the commercial forest land in the South was in small holdings of less than 500 acres.¹ In Mississippi about 75 percent of the forest acres are owned by farmers and other private owners. Statewide wood-using industries own about 15 percent, and the remaining 10 percent is publicly owned.

The importance of Mississippi forests to the economy of the state is to be seen in the fact that of the more than \$286 million in capital investments for new and expanded plants announced for the state in 1965, about 75 percent was by wood-using industries.² It was reported in 1962 by the Mississippi Forestry Commission that "forest products are responsible for 25 percent of the state's dollar movement, 34 percent of the state's payroll, and 40,000 industrial jobs."

The importance of forestry and the distribution of forest tract ownership are two very significant factors in the economic growth of the state. Results of a survey conducted 20 years ago pointed up the fact that even to sustain current timber production and income would require much better timber management than was being practiced.³ Forests owned and managed by wood-using industries and those in public ownership produce twice as many board feet per acre as forests in private holdings.⁴ Experiments by the U.S. Forest Service have shown that small forest tract owners can increase their income

significantly, even in a 10-year period, by following certain recommended practices in relation to their woodland. However, the prospect of additional income apparently has not been sufficient inducement to those owners, if the rate at which they have adopted certain recommended practices is an indication of their interest in forestry as an income producing enterprise.

Professional foresters, economists, and other agricultural leaders have expressed concern about the apparent lack of motivation to adopt improvement practices, and many feel that this is the most serious problems in forestry in Mississippi. In recent years the adoption of recommended forestry practices has been the focus of research in many states in attempts to understand the apparent lack of motivation and to discover ways to promote the use of recommended practices. Studies by sociologists have focused primarily on two facets of the problem, characteristics of adopters of recommended practices and the process of adoption.⁵

Problem and Method

The specific problem dealt with in this study was an attempt to identify social and cultural factors associated with the use of recommended forestry practices by a random sample of rural residents in five Mississippi counties. As pointed out by Lionberger, "whether a farmer will try a new practice quickly or at all is dependent upon many things."⁶ Many studies have shown,

¹U. S. Forest Service, **Timber Resources for America's Future**. U. S. Department of Agriculture Forest Resource Report 14, 1958.

²Mississippi Department of Agriculture and Commerce, "Mississippi Resources, 1966."

³James, Lee M., William P. Hoffman and Monty A. Payne, **Private Forest Landownership and Management in Central Mississippi**. Mississippi Agricultural Experiment Station Technical Bulletin 33, April 1951.

⁴Carlton R. Sollie, **Adoption of Recommended Forestry Practices in Three Mississippi Counties**. Mississippi Agricultural Experiment Station Bulletin 713, July 1965.

⁵For general treatments of the adoption process, see Everett M. Rogers, **Diffusion of Innovations** (New York: The Free Press, 1962), and Herbert F. Lionberger, **Adoption of New Ideas and Practices** (Ames, Iowa: The Iowa State University Press, 1960.)

⁶Herbert F. Lionberger, "Individual Adoption Behavior," **Journal of Cooperative Extension**, I, No. 3 (Fall 1963) p. 162.

with few exceptions, that certain status factors were associated with the adoption of farm practices.⁷

On the basis of research findings, it is safe to state as a basic assumption that adoption behavior is one facet of a configuration of behavioral patterns. The purpose of this study, therefore, is to examine differential adoption of recommended forestry practices in light of selected social and cultural factors.

Data for this study were obtained by interviews in five Mississippi counties. Selection of the counties was based on certain factors which indicated that a study of forestry in the counties would provide significant information. Three counties in north Mississippi were selected because they were located in the Yazoo-Little Tallahatchie Watershed, one of the largest land reclamation projects in the South. Two counties in south Mississippi were selected because they were characterized by a high "burn rate," i.e., many forest fires.⁸

Selection of respondents was by use of a random sample technique which yielded 427 respondents in the three-county area and 259 in the two-county area for a total of 686. All respondents were interviewed by field workers using a standardized survey schedule, and this study is based on data obtained by use of the schedule.

The dependent variable, the focus of the study, was the vote of adoption of recommended forestry practices. This variable was defined operationally as the number of practices adopted from a list of nine specific forestry practices identified by professional foresters as being relevant to the two areas. A typology consisting of three classes was

used for purposes of analysis; the classes were non-adopters (no practices adopted), low adopters (1 or 2 practices adopted), and high adopters (3 or more practices adopted). Low and High Adopter classes were established by use of the arithmetic mean, i.e., the average number of practices adopted which was 2.3 for the sample.⁹

The rate of adoption of recommended forestry practices was examined in light of 11 independent variables, four of which were attitudinal or opinion items. Operational definitions of these 11 variables are provided in the following analysis section. Tests of significance between the dependent and independent variables were conducted by use of the chi-square statistic, and the .05 level of confidence was selected as the basis for accepting or rejecting hypotheses.

Analysis

The first hypothesis tested was that there is a significant relationship between race and the rate of adoption of recommended forestry practices. It was reasoned that race was a significant differentiating feature of the sample, and that whites would have a higher rate of adoption than non-whites.

The sample contained 577 white and 109 non-white respondents, and Table 1 shows the relationship between race and rate of adoption. The test of association showed that no significant difference existed between whites and non-whites in terms of their use of recommended forestry practices.

Although the whites showed a slightly higher tendency to use the recommended practices, the difference could not be attributed to the factor of race.

⁷See, for example, Lee Coleman, "Differential Contact with Extension Work in a New York Rural Community," *Rural Sociology*, XVI, (September 1951); Neal Gross, "The Differential Characteristics of Accepters and Non-Accepters of an Approved Technological Practice," *Rural Sociology*, XIV (June 1949); C. R. Hoffer, *Acceptance of Approved Farming Practices Among Farmers of Dutch Descent*, Michigan Agricultural Experiment Station Bulletin 316, 1942.

⁸Field work for the three-county area was conducted during the summer of 1963 and for the two-county area in the summer of 1965. Agencies responsible for collection, tabulation and analysis of data were the Division of Sociology and Rural Life and the Social Science Research Center at Mississippi State University, the Federal Forest Service and the State Forest Service.

⁹The nine practices were: Planted trees to grow timber, made a road through timber, following a plan and schedule for growing timber, removed cull trees, had timber measured before making a sale, sold timber on a written contract, selected or marked trees to be cut, received bids on timber before selling, and constructed fire lanes.

For both whites and non-whites, as shown in Table 1, more than 50 percent had adopted or used at least one of the practices, and less than 20 percent had adopted or used three or more practices.

Age was considered to be relevant to the study in light of findings of other studies. Bailey and Bryant, for example, found that high levels of fertilizer use were associated with younger age among farmers.¹⁰ Rogers reports that "general evidence seems to indicate that innovators (early adopters) are younger than" those who adopt a practice relatively late.¹¹

For this study, respondents were grouped into four age categories as shown in Table 2.

Examination of this table shows that distribution of adopter types within each age group is very similar to the total sample. For example, the percentage of High Adopters in each age group varies less than two percentage points from the percentage of High Adopters in the total sample.

The null hypothesis of no relationship between age and rate of adoption was therefore accepted, and the conclusion was drawn that age had no effect on the adoption or use of recommended forestry practices.¹²

The third independent variable considered was education. As with age, other studies have shown that education is associated with adoption behavior; as education increases, the tendency to adopt and/or use new practices also increases.

For purposes of analysis, respondents in this study were grouped into three logical categories of education as shown in Table 3.

A statistical test of the relationship between the two variables showed that education did affect the use of recommended forestry practices. Inspection of Table 3 reveals the nature of the relationship, that the use of such practices increases as education increases. It will be noted that 30 percent of the respondents in the upper educational level were High Adopters and that only 16 percent of those in the lower educational level were High Adopters. Non-Adopters showed a tendency to decrease as education increased, increasing the validity of the conclusion that education affects the use of recommended forestry practices.

It was felt that occupation would affect the use of recommended practices, and in order to test the hypothesized relationship respondents were classified

Table 1. Rate of Adoption of Recommended Forestry Practices by Race.

Rate of Adoption	Race					
	White		Non-White		Totals	
	No.	%	No.	%	No.	%
Non-Adopter	253	43.8	53	48.6	306	44.6
Low Adopter	212	36.7	42	38.5	254	37.0
High Adopter	112	19.4	14	12.8	126	18.4
Totals	577	99.9	109	99.9	686	100.0

Table 2. Rate of Adoption of Recommended Forestry Practices by Age of Respondents.

Rate of Adoption	Age							
	Under 39		40 - 49		50 - 54		55 and Up	
	No.	%	No.	%	No.	%	No.	%
Non Adopters	68	47.6	56	39.2	68	45.9	114	45.2
Low Adopters	48	33.5	58	40.6	52	35.1	96	38.1
High Adopters	27	18.9	29	20.2	28	19.0	42	16.7
Totals	143	100.0	143	100.0	148	100.0	252	100.0

¹⁰Wilfred C. Bailey and Ellen M. Bryant, "The Use of Fertilizer by Farmers in Alcorn County, Mississippi," Progress Report in Sociology and Rural Life No. 26. Mississippi Agricultural Experiment Station, August 1962.

¹¹Rogers, *op. cit.*, p. 174.

¹²Since this finding was contrary to the pattern established by other studies, an additional test was conducted with a more refined breakdown of the independent variable. Again, however, the test indicated that no relationship existed.

occupationally as Farm Only, Farm and Non-Farm, and Non-Farm Only. It was found that respondents who were classified occupationally as Non-Farm Only represented approximately one-third of those who had adopted or used any of the specified practices.

Table 4 shows the distribution of cases according to occupational classification and rate of adoption. The statistical test indicated that a significant relationship did exist, and the conclusion was that occupation did affect the use of recommended forestry practices.

Examination of Table 4 shows that respondents classified occupationally as Farm and Non-Farm were the highest adopters; that is, 81 percent of this group had adopted at least one practice whereas 64.5 percent of the Farm Only respondents and 48.1 percent of the Non-Farm Only respondents had adopted at least one practice.

The nature of the practices being studied suggested the need to examine

the possible influence of tenure status on the rate of adoption. Since returns on investments in forestry are long-range in comparison with other agricultural practices, it was reasoned that owners would be more interested in practices related to forestry than non-owners. The reasoning was that non-owners have a higher mobility probability than owners and that they would be less future oriented than owners. A test of the hypothesized relationship, however, indicated that tenure status did not affect the use of recommended forestry practices. See Table 5.

Examination of Table 5 shows that there were just as many High Adopters in the Non-Owner group as in the Owner group. On the other hand, slightly more than 56 percent of the owners had adopted at least one practice whereas slightly less than half of the non-owners had adopted at least one practice. This difference, however, was not statistically significant.

Theory underlying adoption behavior

Table 3. Rate of Adoption of Recommended Forestry Practices by Education of Respondents.

Rate of Adoption	Education							
	1-8 Grades		9-12 Grades		13 or More		Totals	
	No.	%	No.	%	No.	%	No.	%
Non-Adopters	160	45.3	126	53.2	14	26.4	300	44.6
Low Adopters	137	38.8	89	33.3	23	43.4	249	37.0
High Adopters	56	15.9	52	19.5	16	30.2	124	18.4
Totals	353	100.0	267	100.0	53	100.0	673*	100.0

*13 cases of no information excluded.

Table 4. Rate of Adoption of Recommended Forestry Practices by Occupational Classification of Respondents.

Rate of Adoption	Occupational Classification							
	Farm Only		Farm and Non-Farm		Non-Farm Only		Totals	
	No.	%	No.	%	No.	%	No.	%
Non-Adopters	91	35.5	38	40.0	123	51.9	252	42.8
Low Adopters	105	41.0	32	33.7	82	34.6	219	37.3
High Adopters	60	23.5	25	26.3	32	13.5	117	19.9
Totals	256	100.0	95	100.0	237	100.0	588*	100.0

*Does not include 98 cases of retired, disabled or unemployed respondents.

Table 5. Rate of Adoption of Recommended Forestry Practices by Tenure Status of Respondents.

Rate of Adoption	Tenure Status					
	Owner		Non-Owner		Totals	
	No.	%	No.	%	No.	%
Non-Adopters	254	43.6	51	51.0	305	44.7
Low Adopters	221	38.0	36	30.0	251	36.8
High Adopters	107	18.4	19	19.0	126	18.5
Totals	582	100.0	100	100.0	682*	100.0

*No information on 4 cases.

pointed up the need to compare the adoption of forestry practices with the adoption of other practices. Respondents were questioned concerning their use of certain agricultural practices, and in the process of analysis they were classified according to the number of such practices they had adopted using the arithmetic mean as a dividing point. Three classes were identified—those who adopted no agricultural practices, those who had adopted one or two practices, and those who had adopted three or more.

A test of the relationship between adoption of the two types of practices showed that a relationship did exist. See Table 6. Examination of this table shows that slightly more than 70 percent of the High Adopters of forestry practices had adopted three or more of the agricultural practices, and that only about one-third of the Non-Adopters had adopted three or more of the agricultural practices.

The significance of this relationship is the support it lends to the theory that adoption behavior is a complex variable, that such behavior is not a discrete phenomenon but instead is part of a configuration of many factors.

Human behavior must be studied in light of both objective and subjective factors. The six factors discussed above have been treated as objective factors,

that is, factors which are external to the individual. Subjective factors are defined as attitudes and opinions, considered to be internal. Since behavior may be seen as an extension of attitudes, it is reasonable to assume that adoption behavior will reflect certain attitudes toward forestry. In order to test this assumption, respondents were asked a series of questions pertaining to forestry. The questions were structured so the respondents could state whether they agreed, disagreed, or had no opinion. These questions are treated individually here.

The first attitudinal item considered was the statement: You don't have to worry about the woods because Mother Nature will always take care of trees. Responses to this item were about equally divided between those who agreed and those who disagreed with the statement. See Table 7.

Examination of this table shows that almost 75 percent of the High Adopters disagreed with the statement, and that slightly more than half of the Non-Adopters agreed with it. The statistical test showed that a significant relationship existed between rate of adoption and attitude toward the care of trees and the distribution of cases in the contingency table showed that the direction of the relationship was as expected. Among those who agreed

Table 6. Rate of Adoption of Recommended Forestry Practices by Rate of Adoption of Recommended Agricultural Practices.

Rate of Adoption	Agricultural Practices Adopted							
	None		1 or 2		3 or More		Totals	
	No.	%	No.	%	No.	%	No.	%
Non-Adopters	2	13.3	136	54.2	80	32.7	218	42.7
Low Adopters	11	73.3	89	35.4	95	38.8	195	38.2
High Adopters	2	13.3	26	10.4	70	28.6	98	19.1
Totals	15	100.0	251	100.0	245	100.0	511*	100.0

*175 cases not applicable.

Table 7. Rate of Adoption of Recommended Forestry Practices by Attitude Toward the Care of Forests.

Rate of Adoption	Attitude					
	Agree		Disagree		Totals	
	No.	%	No.	%	No.	%
Non-Adopters	151	50.0	144	39.3	295	44.2
Low Adopters	116	38.4	133	36.3	249	37.2
High Adopters	35	11.6	89	24.3	124	18.6
Totals	302	100.0	366	99.9	668*	100.0

*18 cases of no opinion.

with the statement (interpreted as a negative attitude toward forestry), only 11.6 percent were high adopters. Proportionately, more than twice as many of the High Adopters disagreed with the statement.

The second attitudinal item considered was: Putting money into trees is a waste of money. The distribution of responses to this item was much more unequal than it was to the first item. See Table 8.

Approximately three-fourths of the respondents disagreed with the statement, indicating some awareness of the economic possibilities of forestry, but 20 percent of the High Adopters stated that they agreed with the statement. Agreement with this statement was assumed to reflect a negative attitude toward forestry, and it would appear that those High Adopters who agreed with the statement had experienced some disappointments in relation to their forestry practices.

The relationship between rate of adoption and this particular attitudinal item was found to be significant, and examination of Table 8 shows the nature of the relationship. More than half of those who agreed with the statement were Non-Adopters and approximately 60 percent of those who disagreed had adopted at least one practice. The conclusion was that adoption

of recommended forestry practices is influenced by attitudes toward investment in forestry.

The third attitudinal item was: They are damming up too many creeks and rivers in this country. Agreement with this statement was interpreted as reflecting a negative attitude toward forest conservation practices, and only 30 percent of the respondents did agree with the statement. See Table 9. However, the test of significance indicated that no relationship existed between rate of adoption and this attitudinal item. Examination of Table 9 shows that the distribution of cases in the cells was very similar.

The fourth attitudinal item was: The future of this area's economy lies largely in the development and use of forests. Again, no significant relationship was found. Slightly more than 20 percent of the respondents disagreed with the statement, and about 50 percent of these respondents had adopted at least one recommended practice.

The fifth attitudinal item was: Only land fit for nothing else should be used for growing trees. Only 18 percent of the respondents disagreed with this statement and the test of significance showed that no relationship existed between rate of adoption and this item.

Table 8. Rate of Adoption of Recommended Forestry Practices by Attitudes Toward Investments in Forestry.

Rate of Adoption	Attitude					
	Agree		Disagree		Totals	
	No.	%	No.	%	No.	%
Non-Adopters	82	52.2	202	41.1	284	57.8
Low Adopters	53	38.8	191	38.9	244	37.7
High Adopters	22	14.0	98	20.0	120	18.5
Totals	157	100.0	491	100.0	648*	100.0

*38 cases of no opinion.

Table 9. Rate of Adoption of Recommended Forestry Practices by Attitude Toward Forest Conservation Practice.

Rate of Adoption	Attitude					
	Agree		Disagree		Totals	
	No.	%	No.	%	No.	%
Non-Adopters	78	45.1	175	43.4	253	43.9
Low Adopters	63	36.4	147	36.5	210	36.5
High Adopters	32	18.5	81	20.1	113	19.6
Totals	173	100.0	403	100.0	576*	100.0

*110 cases of no opinion.

Summary and Implications

The focus of this study was the rate of adoption of recommended forestry practices and the objective was to identify factors related to differential adoption behavior. Justification of the study was the fact that adoption of agricultural and homemaking practices recommended as a result of experiments is not automatic. That is, the superiority of a new practice over practices already in use does not guarantee its adoption by those who would be defined as potential users. Further, the rate of adoption and the time of adoption of new practices both vary significantly.

In order to test the general hypothesis that adoption of recommended forestry practices varies concomitantly with other factors, a random sample of 686 households in five Mississippi counties was drawn. Interviews were conducted in each of the households and statistical analyses were conducted following the completion of data collection.

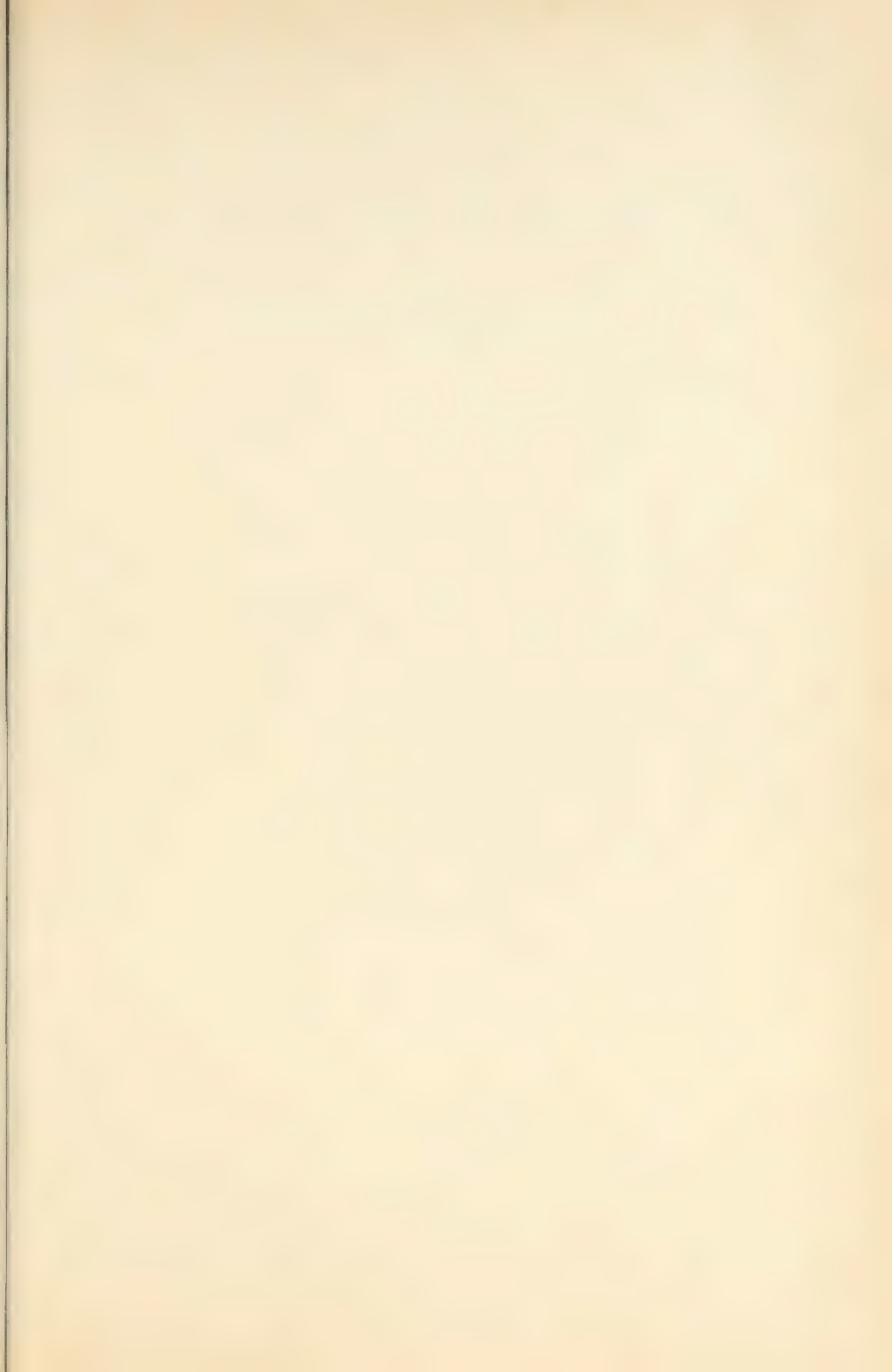
Independent variables selected for this study were race, age, education, occupation, tenure status, agricultural practices adopted, and five attitudinal items. Tests of hypothesized relationships revealed that race, age, tenure status and three of the attitudinal items had no influence on the rate of adoption. Education, occupation, number of agricultural practices adopted and

two of the attitudinal items were found to be related to the adoption of forestry practices.

As in all studies of this nature, causal relationships have been suggested but not proved. What has been demonstrated is the existence of significant relationship between the adoption of recommended forestry practices and certain situational variables, and this has strengthened the theory that adoption behavior is not a discrete phenomenon but is instead part of a configurational phenomenon. That is, whether an individual farmer or housewife will adopt a new practice depends not only on the demonstrated superiority of the practice but on personal characteristics and situational factors.

The main implication of the results of this study for agencies interested in promoting the adoption of recommended practices is that their promotional activities should take account of the fact that something more than the practice itself is involved. Non-Adopters and Low Adopters in this study were characterized by less education, lower adoption of agricultural practices, non-farm occupations and the opinion that investment in forestry is wasteful. Action indicated is that greater effort should be directed toward individuals and groups with these characteristics.





Mississippi Farm Trends 1950-1964

By

ELLEN S. BRYANT and KIT MUI LEUNG

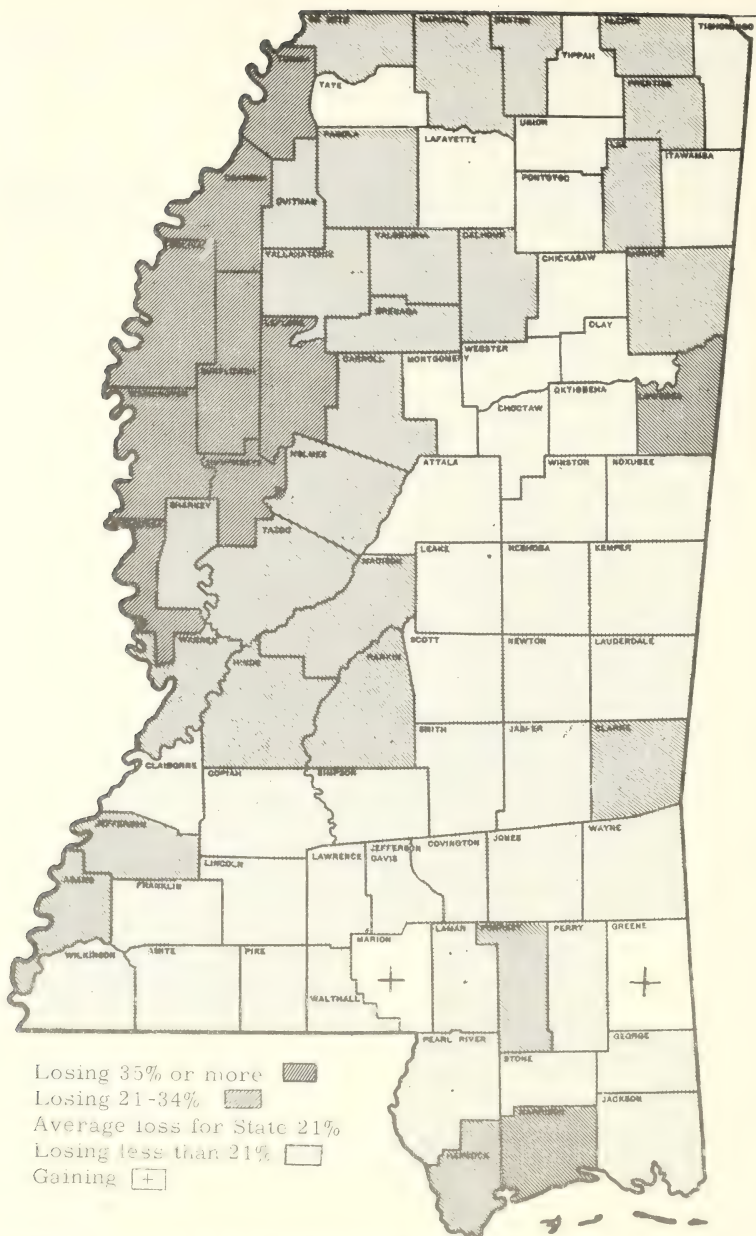


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STATE COLLEGE

MISSISSIPPI



Percent change in number of farms and farmers in Mississippi counties 1959-1964
 --the darker the county the heavier the loss.

MISSISSIPPI FARM TRENDS 1950 TO 1964

By ELLEN S. BRYANT and KIT MUI LEUNG*

Movement out of agriculture in Mississippi is slowing down but the state's farming enterprise continues to adapt to changing economic patterns. The trend is toward increasingly efficient, mechanized, large-scale farming industries and away from the pattern of small, economically marginal, family-operated units which once dominated rural life styles in Mississippi.

Final reports from the latest Census of Agriculture indicate that during the first half of this decade Mississippi experienced a period of continued losses of farms, farmers, and land areas farmed; but concomitant with these losses were readjustments in size of farms and the proportions in categories of ownership, part-time farming, off-farm work, off-farm residence, hired farm labor, and retirement farming.

Trends in Rate of Loss

The total loss of farms and farmers¹ since 1950 amounts to more than 142,000 or 56.6 percent. Nearly 30,000 of this number were removed from farming during the last reported five-year census period. While this latest loss, which amounts to an average state 21 percent decrease, is sizeable, it is considerably less than the 80,000, or 36 percent, of farmers lost during the preceding census period (1954 to 1959), and even slightly less than the 35,000 or 14 percent, leaving agriculture during the first half of the 1950 decade. Thus while losses continue, the peak in outmovement seems to have been reached in the latter part of the 1950's and losses are now beginning to level off.

Peaking of loss rates in the 1954 to 1959 period characterized the trends for both the owner and tenant groups. How-

ever for part-time farming the trend was reversed. For this group, the 1954 to 1959 period was one of growth rather than heavy loss. Similarly, this period saw a reversal from loss to gain in the number of hired farm laborers. The contradictory trends demonstrated by these two latter categories indicate that part-time farming and day labor may operate as residual or adjustment categories which absorb some of the farm population involved in the off-farm movement.

Loss of farm units has, of course, to some extent been counteracted by increases in the average size of units staying in production. The average acreage has in fact doubled from 82.4 acres in 1950 to 162.6 acres in 1964. However the proportion of the state's land area used for farming has also decreased — from 68.5 percent in 1950 and 1954 to 61.6 percent in 1959 to 58.8 percent in 1964, representing a net removal of 850,000 acres from agriculture during the last five years and 3,000,000 acres since 1950.²

County Differences

While the state averaged a 21 percent loss of farmers during the 1959 to 1964 period, county losses varied considerably. As the map in Figure 1 illustrates,

*Assistant sociologist and graduate assistant, respectively, Mississippi Agricultural Experiment Station.

¹In the Census of Agriculture, the number of farms and the number of farmers are always identical. Each farm has one operator, by definition.

²Of the approximate 30 million acres of land area in Mississippi, 20.7 million were in farms in 1950; in 1964, about 17.7 million acres were still in farms.

losses of better than 35 percent were sustained by most Delta counties and by Lowndes and Harrison counties. In Leflore, Sunflower, Tunica and Washington counties, losses hovered at or close to 50 percent. Losses of between 21 and 35 percent occurred in counties bordering the Delta and in many of those having recent and outstanding population growth. Included are several northeastern counties as well as Forrest, Hancock, Adams and Hinds counties. In all, 36 of Mississippi's 82 counties had farmer losses at or above the state's average. Below average losses seem to have occurred in many highly rural hill counties. Two counties in southern Mississippi even recorded a slight net gain of farmers.

Proportional Growth of Owner Groups

Losses have been spread throughout all tenure groups but the sharpest reductions have occurred in the farm tenant group. Over 100,000, or two thirds, of those lost in the 15-year period since 1950 were tenant farmers. As a result, the farm - owner - operator group has grown from a minority status of 48 percent in 1950 to a dominating majority of 76 percent in 1964. The trend away from a predominance of the tenant status to a predominance of the owner status can be traced back to 1930 when less than 30 percent of Mississippi's farmers were farm owners.

Heaviest loss in both owner and tenant groups, as mentioned above, occurred between 1954 and 1959 when approximately 25,000 owners and 55,000 tenants left farming. While loss rates have decreased for both groups since 1959, the two-to-one ratio of tenant to owner loss has continued into the 1960's. The ratio of tenant to owner loss was even higher during the early 1950's when six tenants were leaving farming for every owner-operator lost.

The sizeable losses of farm owners dates back only to 1954. Between 1925 and 1950 gains in the number of farm owners were recorded by every Agricultural Census, and, in the years following World War II, close to 15,000 were added to ownership categories. Apparently, the competitive nature of modern agriculture first affected the marginal tenant farmer but is now also forcing inefficient owner enterprises out of operation.

Farming in Mississippi is becoming less and less a way of life and more and more a business industry. The five-year losses of farm owners for each of the three successive census periods since 1950 have been 5,000, 25,000 and 10,000 respectively.

Nonwhite Losses

Racial differences in farm and farm-tenure loss trends are also apparent. Over half of the total number in farming since 1950 have been white and, by 1964, white farmers were outnumbering nonwhite farmers by nearly two to one, indicating that loss rates of nonwhite farmers have exceeded those for whites by enough margin to affect the racial composition of the farming population. Over 60 percent of the farmer losses during the 1950's were nonwhite; since 1959 this proportional loss has dropped to about 55 percent.

The chief concentration of nonwhite loss has been in the tenant category. Here, nonwhite losses have made up about 80 percent of the total, or 80,000 farmers, during the 15-year period. Nevertheless, in spite of the heavy loss of nonwhites in the tenant category, the proportion of the tenant category which is nonwhite has hovered between 73 and 74 percent since 1950.

In the ownership categories, the largest losses have occurred in the white

population. In the first half of the 1950's there was a five to one ratio of white to nonwhite losses; in the second half a three to one loss ratio occurred; in the first half of the 1960's the loss ratio was still two to one. However, the rate of loss, while higher for whites during the 1950's has been higher for non whites since 1960. The racial composition of the owner groups has continued at about two-thirds white during the entire fifteen-year period.

Part-Time Farming

Part-time farming has long been considered a path out of farming. Presumably, a farmer begins his migration out of farming by supplementing his farm income with an off-farm job. His new work obligations then lead him to reduce farming operations to a part-time basis. As he becomes proficient in his new skills and obtains a degree of security in a nonfarm occupation he may close down his farming operation altogether or even sell his property and move to town.

The recent Agricultural Census does not contradict this possibility. During the 1954 to 1959 period when losses of farmers was most severe, there was an increase in both the number and proportion of part-time farmers in the state. Thus, while some farmers who were faced with a need for economic adjustment may have made a direct transition from farm to nonfarm life, others may have resorted to the part-time enterprise as a means of experimenting with off-farm work or of maintaining a preferred but economically insufficient rural life style.

The table shows that, after increasing during the latter years of the 1950's, part-time farming has decreased, both numerically and proportionally, since 1959. This indicates that some of those who entered part-time farming in the earlier period probably did use it as a

means to achieve ultimate separation from an agricultural occupation.

A further indication of the progressive gradual readjustment of the farming enterprise to general economic and social change can also be had from the statistics on commercial classes of farms. Proportionally and numerically, commercial farms³ increased between 1950 and 1954, but decreased in the latter half of the decade when part-time farming increased. Since 1960, commercial farming has increased proportionally (although not numerically), while part-time farming has decreased. Presumably, the first decrease of commercial farms came when less efficient units shifted to a part-time basis and then increased proportionally as these marginal farmers completed the second stage of their move out of agriculture.

On the other hand some farm operators leaving either rented or owned farms may not be leaving agriculture. The hired farm labor force, while decreasing in the first half of the 1950 decade, has been growing since 1954. In fact the 32,000 regular hired workers, employed 150 days or more a year, counted in 1964 represent an approximate numerical recovery of the 1950 work force size.

The number of farms using hired labor has also increased, from 2.3 percent in 1954 to 5.1 percent in 1959 and to 6.8 percent in 1964. Some of Mississippi's former farmers may also be entering the migratory farm labor streams which

³In general all farms with a total value of products sold amounting to \$2500 or more are classified as commercial if the farm operator was under 65 years and (1) he did not work off the farm 100 or more days during the year and (2) the income received by the operator and his family from nonfarm sources was less than the value of all farm products sold.

follow the crop from Florida to New England and provide needed seasonal farm labor. Approximately 5000 entered this stream from Mississippi in 1965, according to the Employment Security Commission in Jackson.

Evidence of a trend toward integration of town and farm life can also be found in the Censuses of Agriculture. The proportion of farmers working-off-their farm 100 days or more has been steadily increasing. From a slight 8 percent in 1950, the proportion rose to include 34 percent in 1964. If those doing some, but less than 100 days, off-farm work are included, the 1964 percent reaches nearly 50.

It is, of course, not only the part-time farmer who does off-farm work. Another pattern which is increasingly in evidence is a farmer's having a residence which is not on the farm operated. The proportion following this pattern has increased from 2.9 percent in 1950 to 7.5 percent in 1964. While some of the off-farm residences may be rural, some are no doubt town residences. The necessity for a farmer to live on the farm he operates may be rapidly becoming a characteristic of the past. Part-time farming may be a way of getting out of farming but residing off-the-farm may be a way of adopting an urban life style without giving up a profitable agricultural operation.

Retirement Farming

A noteworthy proportion of Mississippi's farms are also operated by retired persons.⁴ Between 1959 and 1964 the proportion increased only slightly, but nevertheless the retention of 15 to 16 percent of farming units by retired or semi-retired persons implies that the next 10 to 15 years will see a further reduction in farming units of at least this proportion, unless, of course, farm youth can be recruited into entering farm occupa-

tions. This does not seem to be occurring to any sizeable extent at present.

The average age of Mississippi farmers has been getting consistently higher since 1950, increasing by about 5 years to 52.8 years over the 15-year period. Thus, unless there is recruitment of youth into farming, half of Mississippi's farmers will be past retirement age in about 12 years. Currently 20 percent are 65 years old or older, and, as noted above a substantial proportion of these are already at least partly retired.

Farm Life Style

Improvements in the average farm family's economic and social levels are also noticeable in figures from the 1964 Census of Agriculture. First, educational levels are increasing. The average number of years of school completed by members of farm households has increased from a low of 4.5 years in 1950 to 8.6 years in 1964. Second, the average size of household decreased from 4.4 in 1950 to 3.7 in 1964, a figure which closely approaches the national average. Third, average farm family incomes are increasing. The general population census gave \$711 as a median family income of the farm population in 1950. In 1960, this same source gave \$1,653 for the median farm family income. The Agricultural Census, including for the first time data on the farm family income, sets the average at \$1,925. Some of this latter increase may result from methodological and sampling differences in the two types of censuses, but it seems reasonable to assume that most of the improvement is real.⁵

Lastly, there have been sizeable improvements in mechanization and use of

⁴Operator 65 years old or over; sales \$50 to \$2,499.

⁵1950 and 1960 data on education and household size are also from the general Census of Population.

electrical home appliances by the Mississippi farm family. Between the years 1954 and 1964, the percent of farms equipped with automobiles nearly doubled; the percent having telephones tripled; the use of home freezers quadrupled, with 16.8 percent having this item in 1954 and 66.4 percent having it in 1964; and the percent possessing television sets increased nearly six-fold to roughly 80 percent at the last census.

Summary and Conclusion

The dominant demographic trends in Mississippi agriculture in the recent past can be summarized, chronologically, as follows:

1. A back to the farm movement occurred during the depression of the 1930's when increments accumulated in both owner and tenant categories. The State had a total of about 312,000 farmers in 1930 and 1935.

2. Since the depression there have been continuous declines in the total numbers of farmers in the state.

3. However, during and immediately after World War II, the state seems to have experienced a limited back to the farm movement which was expressed by numerical growth of ownership categories. In 1950 there were 120,000 farm owners in the state, as compared with approximately 85 to 90,000 during the depression years.

4. Since 1950—the period analyzed by this report—movement out of farming has proceeded more rapidly and the total number of farm operators has been reduced by more than 55 percent between 1950 and 1964, from 250,000 to 109,000.

5. Outmovement since 1950 has occurred among both owners and tenants, but losses of the latter have been much more severe. The ratio of tenant to owner loss was six to one between 1959 and 1954, and since then has been at a two to one loss ratio. Eighty percent of the losses of farm tenants has been nonwhite.

6. Heaviest farmer losses have been in the nonwhite group resulting in a change in the racial composition of farmers from slightly over 50 percent in the white group in 1950 to about 66 percent in 1964.

7. Substantial loss in the ownership categories dates only to 1954. Between 1954 and 1959, 25,000 farm owners left farming. The preceding five-year period saw only about 5,000 leave. The only other recent period during which there was a sizeable net loss of farm owners in Mississippi was between 1920 and 1925, when about 10,000 left.

8. Concurrent with the peak losses of farm tenants and owners between 1954 and 1959, there was an increase in the numbers in categories of part-time farming, farm labor, and migratory farm labor. The inference is that these categories absorbed people who were leaving self employment on the farm but who nevertheless either preferred or were forced to remain in some type of agricultural work.

9. While the number of farmers and the actual land in farming has decreased, the farm units remaining in farming are increasing in size and becoming more mechanized.

10. Farm family living is rapidly becoming urbanized in terms of using convenience appliances and having higher levels of education and income.

In conclusion, there seems to be three patterns of social organization developing within the farming complex in Mississippi. First, agricultural production is being increasingly dominated by large scale, mechanized, efficiently managed white farmer enterprises. Second, supporting these enterprises is a growing group of wage laborers, mostly Negro, which has been displaced largely from inefficient tenant units. Third, there is a growing group of semi-farm, semi-urban

people who are augmenting the blending of town and country life styles. These consist of two subtypes, those who live in town and operate farms and those who live on the farm but have primarily urban occupations.

There is no reason not to expect a continuation of all these patterns. Roads, radios, cars, schools and television, along with an increasingly efficient and grow-

ing industrial economy are urbanizing the aspirations of a large proportion of Mississippi's farm youth. The day of the marginal tenant farmer is in its twilight. That of the small, relatively self-sufficient farm owner is rapidly drawing to a close. The aspects of rural family life that are preserved may well be those that are tied to a blending of urban and rural occupations and residences.

Characteristics of Mississippi farms, farm operators and farm households, 1950 to 1964

Characteristic	1964	1959	1954	1950
Farmers				
Number	109,141	138,142	215,915	251,383
Percent decrease per 5-year period	-21.0	-36.0	-14.1	4.6
Owners				
Percent of total	76.1	67.1	53.7	48.0
Percent white	77.0	75.7	76.1	76.0
Percent nonwhite	23.0	24.3	23.9	24.0
Tenants				
Percent of total	23.5	31.6	45.9	51.6
Percent white	27.5	26.0	26.1	27.5
Percent nonwhite	72.5	74.0	73.8	72.5
Percent 65 and over	20.1	18.0	15.2	13.1
Median age	52.8	51.2	48.2	46.2
Percent working off their farm	34.0	29.9	20.3	8.0
Percent residing off farm operated*	7.5	5.0	4.3	2.9
Regular hired workers**				
Number of workers	31,889	24,817	17,740	33,195
Percent of farms using hired workers	6.8	5.1	2.3	3.3
Farm Households***				
Number of persons per household	3.7	4.4	NA	4.4
Median family income, dollars*	1,925	1,653	NA	711
Median years of school completed, 25 years & over	8.7	8.1	NA	4.5
Farms	109,141	138,142	215,915	251,383
Percent state land area in farms	58.7	61.6	68.5	68.5
Average acres per farm	162.6	134.9	95.9	82.4
By Economic class				
Percent commercial	56.6	53.1	68.8	62.3
Percent part-time	26.1	31.3	12.8	NA
Percent retirement	16.7	15.5	NA	NA
Percent with				
Telephone	40.2	26.7	13.8	6.5
Television	79.1	NA	13.7	NA
Home freezer	66.4	42.6	16.8	4.5
Automobile	65.1	52.8	39.1	26.8

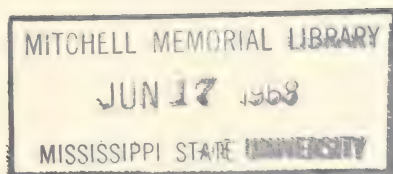
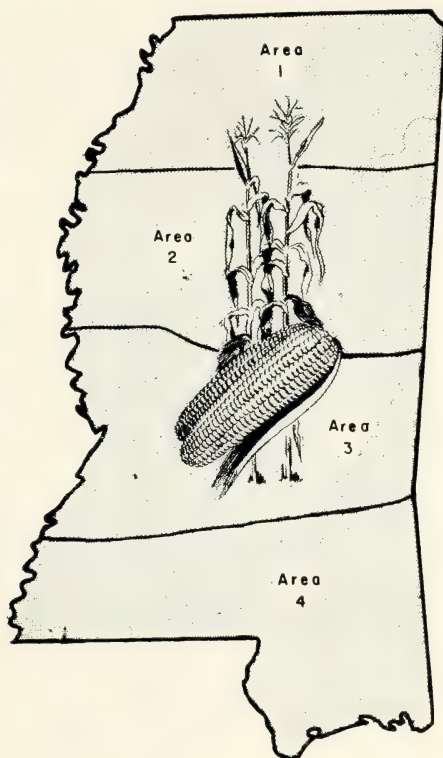
*Published in the preliminary reports.

**Employed 150 days or more.

***Data on Farm households for years 1950 and 1959 are from the 1950 and 1960 U. S. Censuses of Population and apply to the periods for which data was gathered.

Sources: U. S. Bureau of the Census. Census of Agriculture, 1964 Statistics for the State and County Mississippi; Idem., U. S. Census of Population, 1960 and 1950; Idem., Preliminary Report of the Census of Agriculture, 1964, Mississippi.

Mississippi Hybrid Corn Performance Tests, 1967



Mississippi State University
AGRICULTURAL EXPERIMENT STATION

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STATE COLLEGE

MISSISSIPPI

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One of the tests reported was on a private farm through the cooperation of M. A. Luter, Tylertown.

MISSISSIPPI HYBRID CORN PERFORMANCE TESTS, 1967

By LLOYD R. NELSON and GENE E. SCOTT

The 1967 growing season was very good for corn production in Mississippi with the exception of a short dry period at some locations. This lack of adequate moisture was minimized by cool temperatures and timely rain before severe damage occurred.

The State of Mississippi is divided into four maturity areas with 1 being in the north and 4 being in the southern part of the state. Hybrids with a suitable maturity rating should produce best yields within an area.

The 1967 summary and a three-year summary of hybrid performance in each of the four areas of the state have been presented. Results from one year may be more variable than the three-year average. Growing conditions may favor one hybrid one year and another hybrid the next. Therefore, the three-year average for yield is usually more reliable.

Many different characteristics are important in determining suitability of a hybrid for a given purpose. For Mississippi conditions, the characteristics reported in the following tables are believed to be the most important:

Yield—Yield results from many factors, most of which are difficult to measure accurately. The yield values reported are the total amount of corn produced by a hybrid, and do not necessarily reflect the amount of corn that would be picked by a mechanical picker.

Lodging—Plants leaning more than 30 degrees from vertical are considered root-lodged, and plants broken below the ear are counted as stalklodged. The grain from these lodged plants is included in the yield reported, but many of the ears from these plants would not be harvested by a mechanical picker.

Ear Height—The height of the ear is important as it influences lodging and ease of harvesting the crop. Usually a lower ear height is preferred.

Ears Per Plant—This is the average number of ears per plant or degree of prolificness. Prolific hybrids may be able to tolerate a wider range of planting rates than single-eared hybrids and still perform satisfactorily.

Moisture—Differential moisture percentages at harvest indicate differences in relative maturity and rate of drying.

Earworm Data—The percent of ears infested and depth of penetration are considered as direct measures of the amount of damage to the ears. An earworm depth of penetration of 3 inches has been found to cause a loss of 3 bushels per acre. In addition to the direct losses caused by corn earworm infestation, holes and partial destruction of the husk coverage permits and encourages the entrance of a number of other insects; such as, rice weevils and pink scavenger caterpillars. Earworm feeding also gives entrance sites for diseases that cause kernel decay which then attracts other insects. Data reported on husk extension and tightness are supplemental information in that a resistant hybrid usually has a relatively long husk and a smaller silk channel.

There was only a slight infestation of Southwestern Corn Borer in the hybrid tests during the 1967 growing season. Due to early planting, the test at State College escaped serious infestation by Southwestern Corn Borers.

The hybrid test at Pontotoc-Ridge, although producing some high yields, was discarded due to thieves. The test at Poplarville was discarded due to factors beyond the control of the experiment station.

AREA 1, RESULTS OF HYBRID TEST AT HOLLY SPRINGS, VERONA, PONTOTOC (FLATWOODS), 1967

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture		Stand %	Earworm		P.C.W.2/ Infest- ation		Husk	
		Root %	Stalk %			In Grain %	%		Pene- tra- tion In.	Infest- ation %	Exten- sion In.	Tight- ness In.		
Miss. 6133 (Exp)	96.2	4	24	4.1	1.5	13.1	94	0.45	43	15	2.97	0.51		
Dixie 55	94.8	2	21	4.1	1.4	12.8	94	0.52	55	13	3.15	0.56		
Taylor-Evans 6703 (Exp)	89.9	0	21	4.5	1.2	13.9	94	0.67	70	43	2.67	0.64		
Pioneer 511A	88.2	4	13	3.6	1.3	13.5	98	0.82	73	28	2.57	0.63		
Miss. 0002 (Exp)	84.9	2	24	4.0	1.4	13.2	91	0.80	75	38	3.25	0.53		
Pioneer 309B	82.3	6	16	3.4	1.1	13.5	96	0.87	63	35	2.20	0.77		
Pioneer 2425	82.3	6	11	3.4	0.9	13.2	96	1.15	83	23	2.77	0.67		
McNair 440V	81.1	0	19	3.5	1.3	13.3	93	0.67	73	35	2.70	0.68		
McNair 340V	79.0	6	20	3.3	1.1	13.2	94	0.97	73	45	2.10	0.77		
Funks G-5858	78.9	2	17	3.6	1.1	13.3	93	0.75	73	33	2.47	0.70		
Coker 52	78.3	11	10	3.4	1.3	13.5	93	0.52	50	38	2.80	0.60		
Funks G-711AA	77.5	7	23	3.8	1.0	13.9	97	1.17	83	48	1.92	0.83		
Embro Jarvis E1	77.0	4	12	3.1	1.1	12.6	95	1.37	90	35	2.92	0.58		
Asgrow ATC 504	76.7	10	9	3.5	1.0	13.9	91	0.97	88	30	2.27	0.72		
Embro 222TA	76.3	5	20	3.9	1.0	13.2	92	1.05	75	55	2.45	0.77		
Dixie 22	76.2	2	21	4.0	1.2	13.4	93	0.85	73	35	2.85	0.60		
Pennington 9-P-3A	74.8	4	21	4.0	1.2	13.8	89	0.57	73	23	2.97	0.59		
Dixie 18	74.4	4	20	4.6	1.1	13.6	96	0.37	48	28	3.17	0.53		
Taylor-Evans 6704 (Exp)	73.0	0	37	4.5	1.2	13.2	95	0.50	50	28	3.22	0.51		
Pennington CHR-W	66.8	6	24	3.9	1.1	13.6	89	0.75	55	38	2.82	0.59		
McCurdy M97	64.1	6	26	3.7	0.9	12.3	91	1.35	93	38	2.00	0.79		
Asgrow A204	61.3	4	25	3.4	0.9	12.4	93	1.20	80	35	2.30	0.82		
Mean	78.8	4	20	3.8	1.1	13.3	94	0.84	70	34	2.67	0.66		
L.S.D. (.05) D.V. = 13.1	7.93													

L.S.D. (.05)

C.V. = 13.1

1/ Inches from tip of ear. 2/ Pink Corn Worm. 3/ Inches beyond tip of ear. 4/ Diameter of silk channel at tip of ear.

THREE-YEAR SUMMARY PERFORMANCE, 1965-67 (AREA 1)

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture		Earworm		Husk		P.C.W.4/ Infest- ation %	S.W.C.B.5/ Infest- ation %	
		Root %	Stalk %			In Grain %	In %	Pene-1/ tration In.	Infest- ation %	Exten-2/ sion In.	Tight-3/ ness In.			
Miss. 6133 (Exp)	69.3	3	30	3.9	1.4	14.7	0.39	0.39	51	2.94	0.58	17	59.2	28.0
Dixie 55	67.4	1	27	4.0	1.3	14.7	0.38	0.38	51	3.12	0.56	18	67.9	22.4
Pioneer 511A	64.9	3	24	3.4	1.3	14.9	0.70	0.70	66	2.31	0.70	33	55.1	27.8
Pioneer 309B	60.3	3	22	3.3	1.1	14.8	0.72	0.72	60	2.27	0.78	30	53.4	31.9
Funks G-711AA	58.7	4	29	3.6	1.0	15.2	0.96	0.96	68	1.88	0.88	50	59.8	30.5
Dixie 22	56.1	2	24	3.8	1.2	14.8	0.70	0.70	69	2.60	0.68	34	56.0	30.6
Embro 222TA	54.8	2	20	3.8	1.0	14.8	0.79	0.79	64	2.62	0.72	42	53.5	23.6
McCurdy M97	54.1	6	30	3.4	1.0	14.1	1.02	1.02	81	2.41	0.73	48	53.5	21.9
MEAN	60.5	3	25	3.5	1.1	14.7	0.74	0.74	66	2.52	0.70	35	58.2	28.5

1/ Inches from tip of ear. 2/ Inches beyond tip of ear. 3/ Diameter of silk channel at tip of ear.

4/ Pink Corn Worm. 5/ Southwestern Corn Borer.

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture In Grain %	Stand		Earworm		Husk		P.C.W.4/ Infest- ation %
		Root	Stalk				%	%	Pene- tra- tion In.	Infest- ation %	Exten- sion In.	Tight- ness In.	
Funks G-795 W-1	91.7	5	13	3.4	1.4	14.6	93		1.01	80	2.98	.55	93
Dixie 55	91.1	4	22	4.1	1.4	15.0	98		0.94	75	3.46	.51	89
Pioneer 2425	90.5	2	14	3.4	1.1	15.2	96		1.55	95	3.00	.57	100
Funks G-4949	89.3	4	10	3.6	1.3	16.0	98		1.41	95	2.21	.76	99
Dixie 18	88.6	3	26	4.8	1.3	15.1	98		0.88	74	3.47	.51	91
Funks G-720	88.3	7	15	3.7	1.2	15.2	97		1.30	89	2.96	.61	97
Miss. 6133 (Exp)	88.2	2	28	3.9	1.5	14.5	92		1.10	76	3.32	.52	88
Pioneer 3098	86.4	1	18	3.3	1.3	14.7	96		1.27	94	3.04	.56	99
McNair 440V	86.0	2	19	3.7	1.4	15.2	99		1.02	85	2.60	.59	92
Pioneer 511A	85.2	2	20	3.6	1.1	14.9	93		0.87	86	2.98	.54	94
Taylor-Evans 6703 (Exp)	82.3	2	31	4.1	1.2	16.0	96		1.13	90	3.06	.58	100
Funks G-732	81.6	6	14	3.6	1.2	15.8	94		0.94	84	2.91	.63	93
Asgrow ATC 504	81.2	6	10	3.4	1.0	14.9	96		1.23	90	2.88	.59	98
Pioneer 3048	81.2	2	20	3.7	1.2	14.8	97		1.28	94	3.08	.58	100
Asgrow A204	80.2	4	18	3.5	1.2	14.3	97		1.52	90	2.77	.64	94
Miss. 0002 (Exp)	80.2	1	34	3.9	1.2	14.8	101		1.13	83	3.52	.51	96
Funks G-711AA	79.9	3	23	3.6	1.1	15.2	97		1.33	90	2.58	.69	100
Embro Jarvis E1	78.1	4	19	2.8	1.2	14.7	98		1.42	88	2.97	.60	98
Taylor-Evans 6704 (Exp)	77.4	1	36	4.1	1.2	15.0	95		1.22	86	3.57	.53	95
Coker 52	75.8	4	10	3.4	1.3	15.0	89		0.86	75	2.76	.58	89
Pennington 7-C-11A	75.5	1	23	3.8	1.3	15.5	99		0.89	78	3.29	.51	86
Funks G-5858	73.3	3	14	3.3	1.3	15.2	87		1.11	86	3.01	.58	96
McCurdy M306	67.9	1	30	3.8	1.3	15.4	95		1.12	90	3.09	.58	97
Embro Jarvis E	63.9	3	22	2.8	1.0	15.4	91		1.50	97	2.93	.62	97
Pennington CHR-W	63.3	4	21	3.7	1.1	15.1	93		1.17	84	3.18	.60	95
McCurdy M97	62.6	2	31	3.4	1.0	13.8	94		1.47	90	3.01	.62	100
Dixie 22	62.2	1	21	3.7	1.1	15.1	88		1.29	86	3.18	.58	99
McNair 340V	61.5	0	25	3.0	1.1	14.7	95		1.13	81	2.72	.66	95
Mean	79.0	3	21	3.6	1.2	15.1	95		1.19	86	3.02	.59	95

8.1 L.S.D. (.05)

1/	Inches from tip of ear.	3/	Diameter of silk channel at tip of ear.
2/	Inches beyond tip of ear.	4/	Pink Corn Worm.

THREE-YEAR SUMMARY PERFORMANCE 1965-67, (AREA 2)

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture		Earworm		Husk		P.C.W. 2/ Infest- ation %
		Root %	Stalk %			In %	Grain %	Penet- ration In.	Infest- ation %	Exten- sion In.	Tight- ness In.	
Dixie 55	96.0	9	13	4.1	1.5	14.6		.79	.72	3.35	.86	78
Dixie 18	91.0	5	16	4.3	1.4	15.3		.57	.64	3.26	.83	84
Pioneer 511A	89.9	9	10	3.4	1.2	14.8		.68	.83	2.76	.96	68
Funks G-795 W-1	88.1	9	15	3.2	1.4	14.7		.77	.76	2.93	.88	84
Funks G-720	87.8	12	9	3.7	1.2	15.4		.90	.79	2.67	1.04	87
Miss. 0002 (Exp)	86.8	2	22	3.7	1.3	15.0		.75	.72	3.35	.83	86
Funks G-732	86.5	8	9	3.6	1.2	15.7		.84	.83	2.32	1.23	90
Pioneer 3048	82.6	3	11	3.6	1.1	15.1		.99	.86	2.96	.95	91
Funks G-711AA	81.7	14	16	3.6	1.1	14.9		1.00	.86	2.32	1.15	85
Dixie 22	78.2	14	14	3.8	1.2	15.1		.93	.80	2.78	.98	90
Coker 52	77.4	15	6	3.1	1.3	15.0		.62	.73	2.65	.96	72
McCurdy M306	75.3	10	15	3.8	1.3	15.5		.74	.74	3.20	.86	70
MEAN	85.1	9	13	3.7	1.3	15.1		.80	.77	2.88	.96	82

1/ Inches from tip of ear. 2/ Pink Corn Worm. 3/ Inches beyond tip of ear. 4/ Diameter of silk channel at tip of ear.

AREA 3, RESULTS OF HYBRID TEST AT RAYMOND AND NEWTON, 1967

Pedigree	Acre Yield Bu.	Lodging Root Stalk % , %	Ear Ht. Ft.	Ears Per Plant No.	Moisture		Stand %	Earworm		P.C.W.2/ Infest- ation %	Husk		Rice Weevil Infest- ation %
					In %	Grain %		Penet- ration In.	Infest- ation %		Exten- sion In.	Tight- ness In.	
Pioneer 511A	90.6	0 10	3.9	1.4	12.5		95	.82	74	93	2.72	.63	40
Taylor-Evans 6703 (Exp)	89.9	0 17	4.8	1.3	13.6		95	.81	80	99	2.42	.70	41
Miss. 6133 (Exp)	89.8	1 28	4.6	1.6	12.7		97	.80	63	95	3.01	.55	20
Pioneer 3009	84.7	0 5	3.7	1.1	13.4		96	.81	64	92	3.03	.56	15
Dixie 55	84.2	0 20	4.5	1.3	12.1		92	1.05	80	85	2.90	.59	32
Funks G-795 W-1	84.0	0 21	3.4	1.3	12.6		95	1.00	72	97	2.71	.61	32
Pioneer 3098	83.8	0 10	3.7	1.2	12.7		93	1.13	80	89	2.45	.69	22
McNair 440V	82.0	1 8	3.8	1.4	12.9		95	.74	66	91	2.47	.66	22
Pioneer 3048	81.5	0 11	4.1	1.1	12.2		93	1.03	76	87	2.99	.59	22
Funks G-4949	81.1	1 6	4.3	1.2	12.6		97	1.15	80	97	1.78	.83	46
Funks G-5945	80.3	0 8	4.1	1.3	12.9		96	.67	50	95	2.53	.63	24
Miss. 0002 (Exp)	78.2	0 24	4.5	1.3	12.9		93	.65	60	94	2.97	.55	19
Dixie 22	77.8	0 23	4.9	1.2	12.4		96	1.12	78	97	2.70	.66	39
Taylor-Evans 6704 (Exp)	77.4	0 27	5.0	1.3	13.7		95	.27	35	86	3.13	.51	5
Coker 74	76.4	0 10	4.4	1.4	13.5		95	.68	55	90	2.66	.61	5
Embro Jarvis L	76.1	2 26	4.2	1.2	12.2		93	.83	54	91	2.96	.56	22
McNair 340V	73.9	0 17	3.5	1.1	12.4		93	1.03	77	91	1.93	.83	40
McCurdy #306	73.0	0 19	4.9	1.4	13.0		91	.62	50	94	2.76	.63	14
McCurdy #307	72.5	0 15	5.0	1.1	13.6		95	.56	57	85	2.81	.57	16
Embro J-27	72.1	0 27	4.1	1.2	12.4		96	.89	74	96	2.68	.60	34
Funks G-732	67.9	0 8	4.4	1.1	13.0		89	1.13	76	91	1.93	.84	18
Dixie 18	67.1	1 16	5.4	1.2	13.5		94	.53	36	88	3.03	.51	5
Coker 52	66.0	1 9	3.9	1.2	12.7		93	.57	50	75	2.54	.65	21
Mean	78.7	0 16	4.3	1.3	12.9		94	.82	65	92	2.66	.64	24

L.S.D. (.05)

10.5

C.V. = 13.8%

1/ Inches from tip of ear. 2/ Pink Corn Worm. 3/ Inches beyond tip of ear. 4/ Diameter of silk channel at tip of ear.

THREE-YEAR SUMMARY PERFORMANCE, 1966-67 (AREA 3)

Pedigree	Acre Yield Bu.	Lodging		Ears Per Plant No.	Moisture In Grain %	Earworm		Husk		P.C.W.2/ Infest- ation %	
		Root %	Stalk %			Pene-1/ tration In.	Infest- ation %	Exten-3/ sion In.	Tight-4/ ness In.		
Pioneer 511A	70.7	2	23	3.2	1.4	13.7	.71	69	2.46	.72	89
Dixie 55	66.6	1	22	3.7	1.3	13.4	.86	74	3.04	.60	85
Funks G-795-W-1	66.2	1	28	3.0	1.4	13.6	.83	71	2.79	.65	88
Pioneer 3009	65.8	1	12	3.3	3.0	14.0	.70	70	2.90	.63	82
Pioneer 3048	63.9	0	15	3.4	1.1	13.7	.86	73	2.75	.64	84
Funks G-4949	63.2	1	7	3.7	1.1	14.1	.93	76	1.78	.89	90
Miss. 0002 (Exp)	62.5	2	31	3.6	1.3	13.7	.63	61	3.16	.59	90
Dixie 22	62.2	1	25	3.9	1.2	13.7	.79	75	2.37	.77	94
McCurdy M306	60.6	0	20	4.0	1.3	14.4	.57	59	2.97	.63	87
Dixie 18	59.2	3	28	4.0	1.2	14.6	.63	55	2.94	.60	87
Embro Jarvis L	58.4	3	30	3.5	1.1	14.3	.64	60	2.64	.68	84
Funks G-732	57.6	2	10	3.7	1.1	13.7	.91	74	2.00	.87	89
Coker 52	52.2	1	10	3.1	1.2	13.6	.49	55	2.43	.68	83
AVG.	62.2	1	20	3.5	1.4	13.9	.74	67	2.63	.69	87
1/ Inches from tip of ear. 2/ Pink Corn Worm. 3/ Inches beyond tip of ear. 4/ Diameter of silk channel at tip of ear.											

1/ Inches from tip of ear. 2/ Pink Corn Worm. 3/ Inches beyond tip of ear. 4/ Diameter of silk channel at tip of ear.

AREA 4, RESULTS OF HYBRID TEST AT TYLERTOWN, 1967

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture		Stand %
		Root %	Stalk %			In Grain %		
Coker 71	72.1	0	13	3.6	1.5	14.6	98	
Taylor-Evans 6704 (Exp)	72.0	1	32	4.1	1.0	16.8	99	
Pioneer 3009	71.0	0	43	3.3	0.9	14.7	94	
McCurdy M306	70.0	0	17	4.1	1.3	14.8	97	
Coker 74	68.9	0	13	3.3	1.2	15.8	94	
Dixie 18	66.3	0	21	4.6	1.1	15.3	101	
McCurdy M307	66.0	1	28	4.2	1.1	15.5	100	
Greenwood 471	65.9	0	25	3.4	1.2	15.2	97	
Miss. 6133 (Exp)	65.0	0	30	3.8	1.5	14.1	99	
Coker 67	64.1	0	21	3.6	1.3	13.8	97	
Embro 260	63.9	0	20	3.7	1.1	14.5	101	
Dixie 55	62.5	0	29	3.7	1.2	14.4	98	
Funks G-740	62.3	0	34	3.8	1.0	14.2	99	
Coker 811A	61.2	1	18	3.8	1.3	16.3	93	
Miss. 0002 (Exp)	60.7	0	18	3.6	1.2	14.2	98	
Funks G-4949	60.6	1	13	3.5	1.2	13.9	96	
Greenwood 61	59.3	0	15	3.5	1.2	15.0	96	
Taylor-Evans 6703 (Exp)	59.3	0	8	3.6	1.1	14.3	100	
Dixie 22	58.0	0	25	3.8	1.2	14.0	95	
Funks G-5945	57.4	0	27	3.3	1.2	14.1	96	
Coker 52	49.1	0	32	3.2	1.0	14.5	98	
Pioneer 3048	44.9	0	46	3.1	0.8	13.9	96	
Pioneer 3059	37.7	0	58	2.9	0.8	15.4	91	
McNair 440V	35.6	0	51	3.3	0.9	14.4	96	
Mean	60.6	0	27	3.6	1.1	14.7	97	
L.S.D. (.05)								
11.6								
C.V. = 15.2%								

THREE-YEAR SUMMARY PERFORMANCE, 1965-67 (AREA 4)

Pedigree	Acre Yield Bu..	Lodging		Ear Ht. Ft.	Ears Per Plant No..	Moisture		Earworm		Husk	
		Root %	Stalk %			In Grain %	Pene- tra- tion In..	Infest- ation %	Exten- sion In..	Tight- ness In..	
McCurdy M306	63.2	14	20	3.9	1.3	16.3		0.79	72	2.91	0.65
Coker 71	62.9	18	15	3.5	1.3	16.5		0.48	63	2.86	0.63
Coker 67	62.7	13	23	3.5	1.3	16.7		0.50	61	2.84	0.69
Pioneer 3009	62.3	11	23	3.1	0.9	16.7		0.39	69	3.19	0.62
Dixie 18	61.7	5	27	3.9	1.1	16.5		0.58	69	2.69	0.69
Dixie 55	61.6	10	27	3.8	1.2	14.7		0.67	76	3.13	0.67
Coker 74	59.5	10	12	3.2	1.2	20.9		0.72	54	1.90	0.87
Funks G-740	58.8	9	32	3.7	1.1	16.3		0.59	72	2.84	0.67
Funks G-4949	57.1	16	10	3.4	1.1	16.9		1.30	86	1.48	1.09
Embro Jarvis 260	56.8	10	23	3.6	1.1	16.8		0.54	69	2.95	0.66
Coker 52	55.2	10	22	3.0	1.1	16.1		0.45	70	2.30	0.78
Coker 811A	52.3	10	21	3.3	1.2	17.8		0.42	65	2.97	0.65
Pioneer 3048	52.0	7	31	3.2	1.0	15.7		0.56	71	2.95	0.65
MEAN	58.9	11	22	3.5	1.1	16.8		0.61	69	2.69	0.72

1/ Inches from tip of ear. 2/ Inches beyond tip of ear. 3/ Diameter of silk channel at tip of ear.

Mississippi continues to be a corn deficient state. Thus, it should be a profitable location to produce corn. Correct cultural practices to maximize yields would include the following:

A. Plant early—reduce losses from insects and take advantage of favorable growing conditions.

B. Plant an Adapted Hybrid—at a rate 15-20% above the desired final stand.

C. Apply adequate fertilizer—plan for yields of 100 bu/acre or more.

D. Control weeds—with herbicides and/or cultivation.

E. Harvest early—minimize field losses.

1968

Crop and Fertilizer Recommendations For Mississippi

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MISSISSIPPI STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION

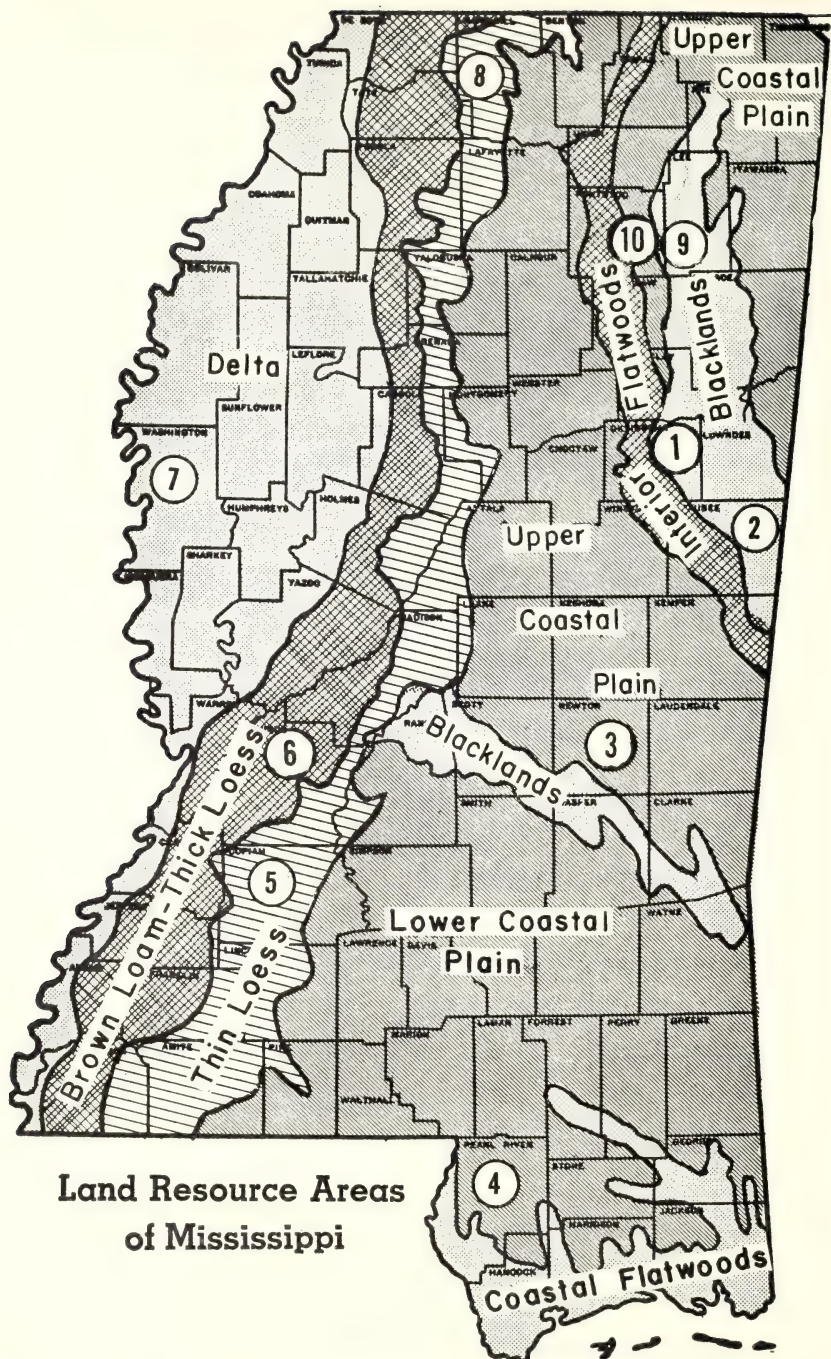
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**Land Resource Areas
of Mississippi**

This map shows land resource areas of the state and how Experiment Station locations fit into them. Number 1 is the main station at State College. Branch stations are: 2 Brooksville, 3 Newton, 4 Poplarville, 5 Crystal Springs, 6 Raymond, 7 Stoneville, 8 Holly Springs, 9 Verona, and 10 Pontotoc.

CROP AND FERTILIZER RECOMMENDATIONS FOR MISSISSIPPI

Crop and fertilizer recommendations are made periodically by the Mississippi Agricultural Experiment Station. These recommendations incorporate the latest research findings at State College and the Branch Experiment Stations. Included is information on varieties and fertilization and seeding practices for crops commonly grown in the state, as well as information on lawns, turf grasses and home gardens.

Because of varying soil and weather conditions and other local factors, no single crop variety or fertilizer recommendation will fit the entire state perfectly; nonetheless, these general recommendations are useful guides for crop production. Of course these recommendations assume that other good farming practices will be followed.

If more specific information is needed, it may be obtained from the Extension Service, the Experiment Station, your County Agent, or other trained agricultural workers in your locality.

Soil Testing Service

The farmer gets maximum profit from fertilizer only when the right kind and amount are used on each field.

Through the Soil Testing Department of the Cooperative Extension Service every farmer can get this information as well as information on liming practices. Furthermore, the Soil Testing Service makes recommendations for exceptionally high production goals which may not be provided for in the general recommendations.

Soil testing is a free service. Soil sample boxes, mailing cartons, and instructions for collecting samples are available in each county agent's office and the offices of other agricultural agencies.

Plant Nutrients

Plant nutrients can be divided into two groups: (1) Those elements used by crops in relatively large amounts, the macronutrients; and (2) those needed in very small amounts, the micronutrients.

The first group includes nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur. These are usually subdivided into the primary fertilizer nutrients — nitrogen, phosphorus, and potassium — and the secondary fertilizer nutrients — calcium, magnesium, and sulfur. The primary nutrients are applied to crops either as straight materials or as mixed fertilizers. Straight materials are those which contain only one fertilizer nutrient. Some examples of straight materials are listed below:

Material	Total Nitrogen (N)
Ammonium nitrate	33.5%
Anhydrous ammonia	82%
Nitrate of soda	16%
	Available Phosphate (P_2O_5)
Superphosphate	18 to 20%
	Available Potash (K_2O)
Muriate of potash	60%

Mixed fertilizers contain two or more of the fertilizer nutrients. Each fertilizer bag is labeled with a set of numbers to show how much of each nutrient it contains. The first number shows the percentage nitrogen (N), the second percentage available phosphate (P_2O_5), and the third the percentage water-soluble potash (K_2O). One hundred pounds of a 5-10-10 fertilizer thus contains 5 lbs. of total N, 10 lbs. of available P_2O_5 , and 10 lbs. of available K_2O . The fertilizer ratio refers to the relative amounts of these nutrients. The fertilizer grade gives the guaranteed amounts of each

fertilizer nutrient as a percentage. For example 8-8-8 and 10-10-10 are two different grades in a 1-1-1 ratio. Similarly, 6-8-8 and 9-12-12 are two grades in a 3-4-4 ratio. Materials such as ordinary superphosphate may be labeled 0-20-0.

At present fertilizer nutrients are either expressed as the oxide, phosphorus as phosphorus pentoxide (P_2O_5), or as the element, nitrogen as N, but there is a trend toward expressing all fertilizer nutrients on the elemental basis. Accordingly, phosphate would be expressed as (P) and potash as (K) by using the chemical symbols for phosphorus and potassium, respectively. The primary "fertilizer nutrients" expressed on the elemental basis would then be shown as N-P-K on the fertilizer bag. Some fertilizers are labeled both ways to familiarize consumers with the new labeling trend. When labeled on an elemental basis a 10-20-20 ($N-P_2O_5-K_2O$) would become a 10-8.2-16.5 (N-P-K). The conversion factors for potash are: $K_2O \times 0.86 = K$; $K \times 1.21 = K_2O$. The conversion factors for phosphate are: $P_2O_5 \times 0.436 = P$; $P \times 2.29 = P_2O_5$. Only the method of labeling is changed not the plant nutrient value of the fertilizer.

For the most part fertilizer recommendations are given in this bulletin as pounds of N, P_2O_5 , and K_2O needed per acre. Usually the farmer will have a choice of more than one fertilizer grade. For example, 48 lbs. N, 48 lbs. P_2O_5 , and 48 lbs. K_2O may be supplied with 600 lbs. of 8-8-8 or 400 lbs. of 12-12-12. Since some deviation from the general recommendation does not affect net profit greatly, it is not necessary to apply exactly the amounts of N, P_2O_5 , or K_2O indicated.

Both the need for and the presence of the secondary nutrients in fertilizers is variable. Research has shown that sulfur deficiency is likely to occur on soils in the Hill Section when sulfur-free fertilizers are used. Accordingly,

sulfur is recommended for crop production in this area, especially for cotton and legumes. A convenient and economical way to get the sulfur is to use mixed fertilizers that contain sulfur. Most solid mixed fertilizers sold in Mississippi contain adequate sulfur, but most liquid mixed fertilizers do not unless special provision is made for the addition of sulfur.

Scattered instances of sulfur deficiency have been observed in the Delta Area. These deficiencies have been associated with land leveling and very sandy soils that are low in organic matter. Since mixed fertilizers are less commonly used in this area, other sources of sulfur may be more economical or convenient to apply. Sources of sulfur that may be used include gypsum, elemental sulfur, ammonium sulfate, and ordinary superphosphate.

Calcium and magnesium are usually applied to soils as agricultural limestone, although a major objective of liming is to neutralize soil acidity. A more complete discussion of liming is given elsewhere. On soils needing magnesium but not requiring lime, the addition of a water-soluble source of magnesium to mixed fertilizers is a very convenient method of applying the magnesium.

The second group of nutrients is referred to variously as "trace elements," "minor elements," and "micronutrients." They are needed by crops in very small amounts. Included are iron, manganese, zinc, copper, boron, molybdenum and chlorine. Thus far, only three (zinc, boron, and molybdenum) of these have found to be deficient to an appreciable extent for crop production in Mississippi. These deficiencies have not occurred on all crops and have been restricted almost entirely to the Hill Section. Specific recommendations for micronutrient are given later for crops which need them.

Solid vs. Liquid Mixed Fertilizers: Mixed fertilizers are available in both solid and liquid forms. Liquid fertilizers have given, or would be expected to give excellent results in most cases, but they are no more effective than many, if not most, solid mixed fertilizers.

Inferiority of some solid mixed fertilizers to liquid mixed fertilizers and to other solids may be attributed primarily to the reduced effectiveness of the phosphate component of these fertilizers. Only highly water soluble phosphates are of necessity, used in the formulation of liquid mixed fertilizers, but the water solubility as well as other characteristics of the phosphate materials in solid mixed fertilizer may vary widely. All highly water soluble phosphates are very effective fertilizers but all those of low water solubility are not.

Solid mixed fertilizers formulated with ammonium phosphates and non-ammoniated superphosphate contain a very high percentage of their phosphorus in a water-soluble form and are just as effective as liquid mixed fertilizers. Ammoniation of ordinary and concentrated superphosphates to add nitrogen during the formulation of mixed fertilizers, which is a common practice, converts some of the highly effective water-soluble monocalcium phosphate to water-insoluble calcium phosphate some of which may be somewhat less effective for crop production. This is particularly true with ordinary superphosphate (20%) because of the formation of an apatite-like calcium phosphate, the quantity of which increases progressively with increasing ammoniation. In a sense new rock phosphate is formed. Consequently, mixed fertilizers formulated from highly ammoniated ordinary superphosphate are not as effective as liquid mixed fertilizer, or other high quality solids. Unfortunately, most of the phosphorus in the apatite-like phosphates formed upon ammoniation of ordinary superphosphate is deter-

mined to be "available" by the chemical method currently used for control purposes.

With the sources of phosphorus commonly used in the formulation of mixed fertilizers in Mississippi, farmers can be reasonably certain of good results if 50 to 60 percent of the "available" phosphorus is also water-soluble. Some manufacturers give the water-soluble phosphorus content of their fertilizers though this is not required by law.

A substantial amount of nitrogen in liquid mixed fertilizers is derived from urea and/or ammonium nitrate. As will be indicated later nitrogen solutions containing urea or urea and ammonium nitrate have been much less effective for surface application to summer pastures than either solid urea or ammonium nitrate. Therefore, liquid complete fertilizers would not be expected to be as effective for summer pastures as solid complete (NPK) fertilizers.

Soil pH and Liming

Excessive soil acidity and associated factors reduce crop yields. A recent summary of soil test results by the Cooperative Extension Soil Testing Department showed that some 70 percent of the soils tested needed lime for legumes and 40 percent for non-legumes.

The degree of acidity or alkalinity of a soil is expressed by its pH; values below 7.0 indicate an acid soil, above 7.0 an alkaline soil. Soil reaction, or pH, affects the availability of some of the more important plant nutrients in the soil. Phosphate is much less available in very acid soils than in slightly acid to mildly alkaline soils. In very strongly acid soils, (pH below 5.0) certain elements such as manganese and aluminum may be changed to forms that are absorbed in such quantities as to be toxic to plants. On the other hand micronutrients such as iron, manganese, boron, and zinc rapidly become less available

as the pH of the soil is increased above 6.0. This is one reason why one must not overlime. Experience has shown that overliming injury in Mississippi is very likely to be associated with deficiencies of boron and zinc. In the case of cotton and legumes, it is very likely to be due to boron deficiency and with corn, and perhaps other grasses, to zinc deficiency.

It has been found that soils with a pH of 6.0 to 7.0 are well supplied with lime and at the same time the other nutrients are maintained in forms sufficiently available to crops. If the pH is less than 5.0, the soil is very strongly acid and is extremely deficient in lime. Most non-legumes grow best at soil pH values of 5.5 and above while most legumes do best if the pH is maintained above 6.0. Alfalfa does best at soil pH values above 6.5.

The amount of lime required to raise the pH of the soil to a desired value depends both on the initial pH and the lime holding capacity of the soil. For soils of Mississippi having a pH of 5.5 or slightly below, the application of 3000 pounds of lime per acre to sandy loam soils, 5000 to 6000 pounds to loam and silt loam soils, and 7000 to 9000 pounds to clay loam and clay soils, respectively, has been satisfactory in correcting lime deficiency for legumes. Since about two-thirds of the soils of the state have pH values of 5.5 or above, and 95% above 5.0, these rates of lime would bring the pH of most of the soils of the state within the range that is favorable for legumes. However, some soils need more, some less, and some no lime. Therefore, the best practice is to test the soils for pH and lime requirement and apply lime as needed to maintain the pH within the desired range.

Lime is lost naturally from the soil by crop removal and by leaching. The use of acid forming sources of nitrogen and the turning under of legumes as soil builders accelerates leaching losses. For example, 100 pounds of nitrogen

from such sources as ammonium nitrate, anhydrous ammonia and urea will cause the loss of calcium and other bases equal to about 200 pounds of lime. When applied annually at this rate, the loss would amount to one ton of lime every ten years due to fertilizer alone. Because of these losses, soils need to be limed periodically.

Generally, on sandy loam, loam, and silt loam soils a maintenance application of 2000 to 3000 pounds of lime per acre once every 5 to 7 years is required for legumes and for non-legumes fertilized with nitrogen as recommended. On clay loam and clay soils less frequent but larger applications are required. Although lime may be needed badly on some soils for non-legumes, the deficiency is not widespread enough to warrant a general recommendation for rates in excess of maintenance requirements for these crops in the absence of a soil test. Areas going into permanent grass sod should receive the initial maintenance application of lime prior to establishment. Subsequent maintenance applications may be applied to the surface.

Except for the dark upland soils and the bottom soils of the Northeast Blackland area, maintenance application should be made to soils that have not been limed during the past 5 to 7 years.

The principal liming materials available in Mississippi are ground calcic and dolomitic limestones, crushed chalk or marl from Mississippi deposits and basic slag. Calcic limestones contain calcium carbonate while dolomitic limestones contain both calcium and magnesium carbonates. Liming materials from Mississippi deposits contain calcium carbonate only. Basic slag, a material containing a minimum of 6 percent P_2O_5 and the equivalent of about 60 percent lime should be used only where both the lime and phosphate are needed. The cost for its use as a liming material only is prohibitive.

Research has shown that all of these materials are very effective in neutralizing soil acidity providing the calcic and dolomitic limestones are finely ground. Particles not passing a 40-mesh screen (40 holes per linear inch) are not very effective in neutralizing soil acidity. For this reason 90 to 100% of calcic and dolomitic limestones should pass a 10-mesh screen and 50% a 100-mesh screen. Particle size is not as important in the case of chalk because it contains clay as an impurity which causes the particles to break down within the soil. It must be crushed fine enough, however, to be spread uniformly.

Generally, the Delta and Deep Loess soil areas are abundantly supplied with magnesium, therefore dolomitic lime is of no advantage in these areas. In the other soil areas of the state, however, magnesium levels tend to be lower and a liming material containing considerable magnesium, such as dolomitic lime, should be used; particularly in the North-east Blacklands.

For best results lime should be mixed thoroughly with the top six to eight inches of the soil. However, depending on the texture of the soil, a maintenance application of 1000 to 2000 pounds per acre may be made as a surface application to permanent pastures, or other permanent sods.

Fertilizer Efficiency

The objective of fertilization is to increase the net profit per acre. The profit obtained from fertilizers depends somewhat on how efficiently it is utilized by the crop. Two factors that may affect greatly the efficiency of the fertilizer are time and method of application.

Time of Application: In general, fertilizer nutrients are reduced in effectiveness following their application to the soil because of losses by volatilization and leaching, and by conversion to less available forms within the soil.

Fertilizers may contain nitrogen either in the form of nitrate or ammonium, or both, or in other forms (urea and cyanamide) that are changed rather rapidly to ammonium when applied to the soil. Nitrate salts found in fertilizers and in soils are highly soluble in water. Since they are not retained by combining with the soil, they are easily leached from the root zone, particularly on sandy loam loam, and silt loam soils or other soils where water percolates easily through the soil profile. Under water-logged conditions, particularly in clay soils, nitrates may be changed by soil organisms (denitrification) to gaseous nitrogen which escapes into the atmosphere. Ammonium nitrogen is not denitrified; neither is it easily lost by leaching because it combines chemically with the clay and organic matter. However, it is soon converted by soil bacteria to nitrate salts which may be lost.

Since nitrogenous fertilizers are not retained in soils for long periods, maximum efficiency for crop production is generally obtained by applying them at or near the beginning or during the growing season.

Phosphate fertilizers are not lost from soils by leaching, but their effectiveness for crops is reduced. In acid soils they react rather rapidly, particularly with iron and aluminum to form phosphates that are much less available to plants. These reactions are referred to as "phosphate fixation." Because of this fixation, annual, seasonal applications of phosphate are more effective than less frequent or off-season application. This is true for both annual and perennial crops. In general, best results are obtained by applying phosphate fertilizers at or just prior to seeding, or near the beginning of the growing period in the case of maintenance applications to perennial crops.

The effectiveness of potassic fertilizers is not reduced appreciably by fixation

in Mississippi soil, as is phosphate. Also, potash is not as easily leached from soil as is nitrate. However, on sandy loam, loam, and silt loam soils the extent of loss by leaching is such that annual, seasonal application are better than less frequent application. Also, excessive uptake (luxury consumption) and removal of the potash in the harvested portion of forage crops makes annual, and sometime split, seasonal applications necessary for optimum efficiency.

Fall or winter plowing to prepare a seed bed is necessary for most successful production of row crops on heavy clay soils such as occur in the Blackland Area and the Delta. Where equipment is not available for proper placement of fertilizer in a prepared seed bed in the spring, the phosphate and potash, and magnesium, if recommended, should be applied at the time the seed bed is prepared. The method of application should be such that the location with respect to the seed row will be in conformity with the recommendations for the crop in question. Except for the black clay upland soils and the clay bottom soils of the Northeast Blackland Area or other clay soils known to be slightly acid to alkaline in reaction, the recommended rate of phosphate should be increased by about 50 percent if applied in the fall or winter.

From the foregoing observations it is evident that the soil, fertilizer and crop characteristics must be taken into account in order to time the application of fertilizer so that maximum availability to and need by the crop are made to coincide in so far as it is practical to do so. This is reflected in the recommendations given later.

Method of Application

To obtain maximum efficiency from fertilizers there are two components of availability that must be made optimum concurrently; namely, chemical and positional availability. Chemical availabil-

ity refers to the capacity of the fertilizer and its soil-reaction products to supply nutrients to plants. Positional availability refers to the location of the fertilizer with respect to the plant roots. For example, fertilizer placed in the soil a foot or so from the row is positionally unavailable to seedling plants.

The chemical availability of nitrogen and potassium in fertilizers usually is not affected greatly by degree of contact with the soil. However, the effectiveness of highly reactive phosphates is improved by reducing their contact with the soil because the rate of phosphate fixation is reduced. This may be done either by band placement in the soil or by granulation of the fertilizer at the factory. Since most solid fertilizers sold in Mississippi are granulated, or pelletized, the effect of method of application is on positional rather than chemical availability.

To provide the most effective positional availability, fertilizers should be placed so as to be intercepted by plant roots at an appropriate time, or be moved to plant roots with soil water. As plants grow and extend their roots both horizontally and vertically the volume of soil from which nutrients may be absorbed is increased. Therefore, fertilizers placed so as to be positionally unavailable during early plant growth may become available later.

Phosphate does not move appreciably in soils and the movement of potash is somewhat limited, especially on soils of medium to fine texture. Therefore, these fertilizers must be placed so as to be intercepted by plant roots. For drill-seeded and row crops they should be placed in the soil deep enough to be in moist soil where plants feed during the growing season. For such crops surface application or shallow incorporation, as by disking, would be expected to give inferior results because of poor positional availability. Nitrogenous fertilizers

applied to the surface of the soil, particularly when dry, remain positionally unavailable for the most part until dissolved and moved down into the root zone by percolating water. Before the ammonium form of the nitrogen in fertilizers is moved down into the root zone, it must be changed (nitrified) by soil bacteria to the nitrate form, a process requiring two or more weeks for completion in moist soil during warm seasons. By applying nitrogenous fertilizers far enough in advance for the necessary transformations and movement into the root zone by rainfall to occur by the time the nitrogen is needed by the crop, unfavorable positional availability is avoided.

Localized concentration of immobile fertilizers nutrients, such as phosphorus and potassium, near the row or drill, as by band application, provides the most favorable opportunity for early interception by plant roots as well as for extensive root development within the fertilized zone later, a condition which contributes to optimum fertilizer efficiency. An outstanding benefit from phosphorus is its favorable influence on the early growth and development of plants which also is enhanced by localized placement near the row.

Since nitrogen as nitrate does move with the soil water to plant roots, its over-all efficiency is not affected greatly by degree of concentration or its location within the root zone except that enough nitrogen should be positionally available for optimum growth of young plants.

Although maximum efficiency of phosphate and potash are usually obtained by band placement on row crops and drilled seeded crops, top yields can be obtained with broadcast application of these fertilizers. However, on soils that are rather low in available phosphate and potash the rate of application probably would have to be increased by a factor of 1.5, or more, to obtain the same

yield as when banded, especially when the fertilizer is incorporated by shallow disking instead of being plowed under.

Because of accumulation from previous applications, only a small percentage of the row-crop land previously cropped to cotton and fertilized as recommended over a long period would be expected to be so low in phosphate and potash as to require an appreciable increase in the fertilizer rate to obtain essentially the same yields when broadcast as when banded beside the row.

A hazard of localized placement of the fertilizers near the row is salt injury to seeds and seedlings resulting in poor stands and stunted growth. Since fertilizer salts, such as nitrates and chlorides, move mostly upward and downward with soil water rather than laterally by diffusion, salt injury can be avoided by placing the fertilizer to the side of rather than beneath the seed. The distance of separation required depends upon the kind of fertilizer and the rate of application. For recommended rates of phosphate and potash and up to about 40 pounds of nitrogen per acre, the minimum distance of separation should be 3 to 4 inches to the side of and 3 to 4 inches below the seed. With higher rates of nitrogen or potash both the horizontal and vertical distances between seed and fertilizer should be increased, or the fertilizer should be broadcast and plowed under.

Surface application of phosphate and potash to sod crops is more effective than for row crops except during periods of drought. This is because of the development and persistence of plant roots near the surface; in fact, this method is so effective that it is recommended for making maintenance applications of fertilizers to perennial close-growing crops. Solid sources of nitrogen are much more effective for surface application to summer pastures than are the urea-ammonium nitrate solutions, such as N-Sol-32

and Uran. Thus far, these solutions have ranged in effectiveness from 55 to 75 percent of that of solid ammonium nitrate.

Foliar Feeding

Plants absorb and utilize nutrients applied in solution to their leaves and if a deficiency exists, yields and/or quality may be improved by foliar application. Because they are required in such small amounts, very dilute nutrient salt solutions of the micronutrients (trace elements) may be used quite satisfactorily as foliar sprays to correct deficiencies without injury (burning) to foliage. In some areas foliar feeding of trace elements has become a somewhat standard practice for crop production. Frequently, micro-nutrients are applied conveniently and inexpensively along with insecticides and fungicides. A typical example is the application of boron to cotton with the insecticide. However, so far, under Mississippi conditions there appears to be no need for both foliar and soil applica-

tion of micronutrients where they are needed for crop production.

The primary (nitrogen, phosphorus, and potassium) and secondary (sulfur, calcium, and magnesium) nutrients, are absorbed in relatively large quantities by crops. Thus, to supply a substantial part of the total requirement of these nutrients without burning the leaves of plants would require several applications of rather dilute solutions during the growing season. Therefore, foliar feeding of these nutrients is not as feasible as foliar feeding of the micronutrients. Increases in the yield of cotton have been obtained in Mississippi under certain conditions from foliar feeding of the primary nutrients, but it has not been shown so far to be a desirable or economical alternative to soil application of these nutrients. Therefore, foliar feeding is not now recommended routinely in lieu of or as a supplement to soil application of plant nutrients.

Recommendations for Major Field Crops

CORN

Varieties: Detailed results of variety trials are published annually in Mississippi Farm Research.

Seeding Dates and Rates and Land Selection: Plant in North Mississippi from April 1 to April 25, in North Central Mississippi from March 25 to April 20, in South Central Mississippi from March 15 to April 15, and in South Mississippi from February 25 to March 15.

Corn should be planted on deep to moderately deep soil with fair to good surface drainage. Steep, droughty, and eroded hillsides are not well suited to corn. It is desirable to use the minimum stand that will give near maximum yield for a given set of conditions. Yields are affected by weather, soil productivity, fertilization practices, and other factors. Stands should be adjusted on the basis of average yield expected, and under Mississippi conditions should range from

8,000 to 14,000 plants per acre with prolific varieties. Stands should not exceed 12,000 plants per acre except on highly productive soils or where irrigation is practiced. On the more productive soils, such as bottomland soils and deep to moderately deep nearly level to gently rolling upland soils, stands should be 10,000 to 12,000 plants per acre, on the less productive soils 8,000 to 10,000 plants per acre. A good rule-of-thumb is to provide about 120 plants for each bushel of expected yield.

Fertilization—Hill and Delta Foothill Areas: Soils of the Hill and Delta-Foothill Area generally require a complete fertilizer for corn. Soils should be limed to maintain the pH above 5.5. Occasionally, following the application of lime, zinc deficiency may be encountered, especially on soils of medium to coarse texture. When this occurs, a mixed fertilizer containing zinc should be used.

No other micronutrient deficiencies have been observed in corn.

Time: Apply all of the phosphate and potash before planting. Nitrogen may be applied before planting or in split applications. As a rule it is advantageous to apply two-thirds or more of the nitrogen as a side-dressing. The side-dressing should be made by the time the corn is knee high.

Rate: Depending upon the stand apply 40 to 70 pounds each of phosphate (P_2O_5) and potash (K_2O) and, 120 to 220 pounds of nitrogen per acre, increasing the fertilizer rate as the stand is increased. For example, with 10,000 to 12,000 plants, the nitrogen rate would be 150 to 180 pounds per acre. If corn is to be grown continuously for silage on the same field for several years, apply 50 to 60 pounds of phosphate and 100 to 120 pounds of potash per acre in a 1:2 ratio.

Method: Apply the phosphate and potash and up to 40 pounds of nitrogen in a band 3 to 4 inches to the side and 3 to 4 inches below the seed. The remaining nitrogen may be broadcast, drilled at least six inches from the row or applied as a side-dressing. If all the nitrogen is applied with phosphate and potash the fertilizer should be broadcast and plowed under. Preplant application of anhydrous ammonia should be placed at least 6 inches to the side of and 6 inches below the seed.

For most efficient results, side-dress applications of nitrogen should be placed a foot or more from row, non-pressure solutions and solid sources at a depth of 4 inches and anhydrous ammonia at a depth of 6 inches. However, surface application of solid sources and non-pressure solutions is only slightly less effective than in-soil placement.

Fertilization—Delta Area: For soils in this area, only nitrogen is needed generally for top production. Soil test for phosphate and potash needs.

Time: Nitrogen may be applied just prior to planting or in split application: one-half at or before planting and the rest as a side-dressing before the corn is knee high.

Rate: 130 to 220 pounds of nitrogen per acre, increasing the rate as the stand is increased.

Method: Place preplant applications of nitrogen 6 or more inches from the drill row, non-pressure solutions and solid sources at a depth of 4 or more inches and anhydrous ammonia at a depth of 6 inches below the level of the seed. Side dress applications of nitrogen should be placed 1 foot or more from the row, non-pressure solution and solid at a depth of 4 inches and anhydrous ammonia at a depth of 6 inches. Surface application of solid sources and non-pressure solutions is only slightly less effective than in-soil placement.

COTTON IN THE DELTA

Varieties: Results of variety tests are published annually in Mississippi Farm Research.

Seeding Dates and Rates: Plant as soon after April 1, as weather permits, but not in cold soil. Hill dropped—16 to 22 pounds of delinted seed per acre. Drilled—30 to 40 pounds of delinted seed per acre. Drilled for cross plowing—60 pounds of delinted seed per acre. Seed should be of good viability.

Fertilization: Delta soils generally need only nitrogen fertilizer for most profitable yields, but in the Foothills area and sometimes elsewhere the use of phosphate and potash may be profitable. Therefore, soils should be tested for phosphate and potash needs. Soils should be limed according to soil tests to maintain the pH above 5.5.

Time: Apply nitrogen in the spring at or prior to planting, except on sandy loam soils having very good to excessive internal drainage and on clayey soils with poor surface drainage. On such

soils, split application of nitrogen should be made, one-half at or prior to planting and the rest as a side dressing preferably by mid-June. Split application of nitrogen on clays with poor surface drainage is recommended because of possible loss of nitrogen by denitrification during wet periods.

Rate: On sandy loam, loam, and silt loam soils rates from 90 to 100 pounds of nitrogen per acre are recommended for solid planted cotton and for all skip-row patterns. 100 to 120 pounds of nitrogen per acre is recommended for the silty clay loam, silty clay, and clays regardless of the planting pattern, except that for clays with poor surface drainage the rate should be 120 to 150 pounds of nitrogen per acre.

For cotton following soybeans or pasture sod, the nitrogen rate should not exceed 60 pounds per acre, especially following pasture sod.

The nitrogen rate should be reduced to 75 pounds per acre on soils where stalk growth is too rank, maturity too late, and boll rot is a problem. If there is evidence of deficiency, the rate should be increased 30 percent.

All nitrogen fertilizer recommendations are on the basis of a planted acre regardless of the planting pattern, that is, whether skiprow or solid.

Method: Same as for corn in the Delta Area.

COTTON IN HILL AREAS

Varieties: Results of variety tests are published annually in Mississippi Farm Research.

Seeding Dates and Rates: Plant between April 10 and May 10 as weather permits. Hill dropped—use 16 to 22 pounds of well delinted seed or 12 to 16 pounds of acid delinted seed per acre. Drilled — use 20 to 30 pounds of well delinted seed or 15-20 pounds of acid delinted seed per acre. All seed planted should be of good quality.

Fertilization: A complete fertilizer (NPK) containing sulfur and boron is needed in the Hill Sections. Fertilizers for the dark upland soils of the Northeast Blackland Area having a pH above 6.0 should contain enough water-soluble magnesium to supply at least one-half and preferably as much magnesia (MgO) as potash. On soils more acid than pH 6.0 magnesium deficiency may be corrected by applying dolomitic lime at the rate of one to two tons per acre, or as indicated by a soil test, to supply magnesium.

Enough boron is provided when the mixed fertilizer contains boron and phosphate in the proportion of 0.3 pounds to 48, respectively, or a boron to phosphate ratio of 1:160. No more than 0.5 pounds of water-soluble boron should be drilled with the fertilizer close to the seed.

Acid soils should be limed according to soil tests to maintain the pH above 5.5.

Time: Apply the phosphate and potash and all or part of the nitrogen at or a few weeks before planting time. On deep sandy or sandy loam soils with very good to excessive internal drainage, side dress one-half to two-thirds of the nitrogen for most effective results. Make side-dress applications of nitrogen by mid-June (a week or more earlier if anhydrous ammonia is used), or at early square formation.

Phosphate and potash may be applied in the fall to certain clay soils of the Blackland Area with good results—see section on Fertilizer Efficiency.

Rate: Apply 72 pounds of nitrogen (N) and 48 pounds each of phosphate (P_2O_5) and potash (K_2O) per acre except as follows: Increase the nitrogen to 120 pounds and phosphate and potash to 60 pounds each per acre on the dark upland soils of the Blackland Areas, and increase the nitrogen to 90 pounds per acre on the well-drained bottom and on the level to gently sloping upland soils of the Upper Coastal Plain. Excessive stalk growth and

delayed maturity indicate too much nitrogen. Somewhat stunted growth associated with yellowish green foliage and the early yellowing and premature shedding of the leaves indicate too little nitrogen. When these conditions are observed nitrogen rates should be adjusted accordingly.

Where a skip row planting pattern is followed the rate of nitrogen per planted acre should be the same as is recommended for solid cotton but the rate of phosphate and potash should be increased to 60 pounds of each per acre where a lower rate is recommended for solid cotton. In a 4 x 4 or 2 x 2 planting pattern there is, of course, only one-half acre of planted cotton.

Method: Same as for corn in Hill and Delta Foot Hill Areas. Contact placement of seed and fertilizer as well as placement directly beneath the seed should be avoided.

SOYBEANS

Varieties: **Delta Area** — Hill, Dare, Hood, Lee, Semmes, and Bragg (listed in order of maturity).

Hill Section: North — Hill, Dare, Hood, Lee and Bragg. South—Bragg and Hampton 266; Hardee in extreme south.

For all areas where soils are infested with cyst nematode use the variety, Pickett.

Soils: Soybeans are adapted to all Delta soils and to most soils of the Hill area, but lower yields may be expected on droughty soils such as eroded and shallow upland soils.

Seeding Dates and Rates: May 1 to June 15 except extreme South Mississippi June 1 to June 20. Plant 40-50 pounds of good seed per acre.

Inoculation: If not on land where a crop of well nodulated soybeans has grown within the last five years, the seed should be inoculated.

Fertilization—Delta Area: Soybeans require no fertilizer on most Delta soils

but a high percentage need lime. A soil test will indicate the need for lime as well as phosphate and potash.

Fertilization—Hill Area: In the Hill Area, phosphate and potash as well as lime usually are needed. Except for the dark soils of the Blackland Area of Northeast Mississippi, some 70 percent of the soils of the Hill Area need lime for top yield. In the absence of a soil test, apply both phosphate (P_2O_5) and potash (K_2O) in a 0-1-1 ratio at the rate of 40 to 50 pounds per acre in a band 3 to 4 inches to the side and 3 to 4 inches below the seed, or at the rate of 60 pounds per acre if broadcast and plowed down. Avoid contact placement with the seed as well as band placement directly beneath the seed. Much newly cleared land, as well as land in unfertilized pastures, is extremely deficient in phosphorus and the rates indicated above probably will not be adequate for most profitable yields if this land is planted to soybeans. On such land the phosphate should be increased to 80 pounds per acre for a few years by using a mixed fertilizer of 0-4-3 ratio.

In some parts of the state double cropping of small grain and soybeans may be practiced. In such a system it would be satisfactory to apply all of the phosphate and potash recommended for both crops to the small grain.

Molybdenum is a trace element required by plants and the nodule bacteria of legumes. A seed treatment with molybdenum at the rate of $\frac{1}{4}$ oz. of sodium molybdate per acre or its equivalent has increased yield of soybeans in the Hill Areas about 7 bushels per acre on strongly to very strongly acid soils and about 2 bushels per acre on soils that do not need lime, pH 6.0 or above. Decreasing response to molybdenum with increasing pH, or lime content, occurs because the native soil molybdenum becomes more available. Based on results so far, it appears that a seed treatment

with molybdenum may be needed for top yields regardless of the lime status of the soil. Certainly, it is needed if the soil is not known to have a pH of 6.0 or above.

RICE IN THE DELTA

Varieties: Long Grain: Bluebonnet 50, Starbonnet, Dawn, and Bluebelle which mature in 150, 142, 130 and 115 days respectively. Medium grain: Saturn, Nato and Nova 66 which mature in 125-130 days.

Seeding Dates and Rates: Rice can be seeded from mid-April to mid-June depending upon variety. The very early varieties should not be planted until June. Seeding rate 90 to 110 pounds if drilled and 110 to 135 pounds if broadcast or water seeded.

Fertilization: Apply from 80 to 120 pounds of nitrogen per acre on old crop land. New land will probably require no nitrogen for the first one or two years. The ammonium forms of nitrogen such as ammonium sulfate and urea are recommended. Fertilizer may be applied before seeding if covered by approximately 2 inches of soil. Otherwise, it may be applied just before the first flood or one-half before the first flood and one-half at the correct 'joint stage.' This stage occurs when the first internode or distance between the lowest two joints is 3/4 inch for very early varieties, and 1-1/2 inches for the early and midseason varieties. Should all the nitrogen be applied in the flood water the rates should be increased 20 percent.

SORGHUMS FOR GRAIN, SILAGE

Varieties for Grain: AKS 614; De-Kalb's C44B, E57, BR60, BR62, and F64; GA 615; Lindsey 555; NK227; P.A.G. 515S; Ranger B; RS 610; Savannah; and TE66.

The above varieties may also be used for silage, especially when grown for high producing milk cows. Where high-

er yields per acre but with somewhat lower quality are desired, the varieties listed for silage (below) should be used.

Varieties for Silage: FS1A, NK300, 101F.

Seeding Dates and Rates: April 20 to July 15. Earlier dates are preferred. If first harvest is made by July 25, a second cutting can usually be made if soil moisture is adequate.

Rates for Grain — Seed 6 to 9 lbs. of seed per acre in rows; for silage use 4 to 6 lbs. per acre in rows.

Fertilization:

For Grain: In Delta apply 120 to 180 lbs. of nitrogen only.

In Hill section apply 100 to 130 lbs. of nitrogen at seeding along with 30 to 40 lbs. of P_2O_5 and 30 to 40 lbs. of K_2O . Where a second cutting is desired apply an additional 40 to 60 lbs. of nitrogen after the first cutting.

For Silage: Apply as for grain, except double the rate of potash.

Method of Application: Same as for corn.

SUGARCANE FOR SIRUP

Varieties: C. P. 36-111. On deep, well drained soils of light texture.

Seeding Dates and Rates: Cut seed cane at the top mature joint and at ground level, but do not strip before planting. Plant in the Fall (October 15) at the rate of 2 stalks, that is, place stalks end to end with a whole stalk at the union. Plant the cane in 4-foot rows on land that has been broken 5 to 6 inches deep a few weeks earlier. To protect from cold and to provide good drainage, cover the cane 6 to 8 inches deep by forming a ridge over it so that the drainage furrows between the rows are 2 to 4 inches deeper than the cane.

Fertilization: In the spring apply 40 to 50 pounds each of nitrogen and phosphate (P_2O_5) and potash (K_2O) per

acre shortly after germination of the eyes or just before re-growth from stubble. Place the fertilizer in a band so that it will be 4 to 6 inches to the side of the row and 3 to 5 inches deep after the ridges have been worked down, or 1 to 2 inches deeper than the cane. Side-dress with about 30 pounds of nitrogen

per acre before July. Place side-dressing nitrogen in the edge of the root zone deep enough to be in moist soil without being disturbed by subsequent cultivation.

Strip, top, and cut the cane before freezing weather. Harvesting as much as a month before processing improves sirup quality and reduces "sugaring."

Grasses, Legumes, and Small Grains

(See Tables on pages 18-24)

Supplementary Information on Pasture Recommendations for the Hill Section

Planting:

If equipment is available, drill or band placement of seed and fertilizer is recommended for the establishment of all pasture and forage crops. With small-seeded legumes and grasses, care must be taken not to seed too deep. A seeding depth no more than $\frac{1}{2}$ -inch is recommended. Most plantings are made by broadcasting the seeds on the soil surface. In which case the seedbed should be cultipacked immediately before or after seeding.

Bloat Clover Pastures:

Where conditions are especially favorable for legumes the danger of bloat may prevent full utilization of legumes seeded alone or of grass-legume combinations such as Dallis-grass and white clover, particularly in the Deep Loess area. The drilling of small grains or ryegrass into such a pasture will lessen the bloat problem and supply additional forage. In North Mississippi, orchardgrass may be seeded to reduce bloat in clover pastures.

Fertilization: For established pastures, solid and liquid complete fertilizers and solid sources of nitrogen may be top-dressed. On summer grass pastures, however, the efficiency of top-dressed urea-ammonium nitrate (non-pressure) solutions has been quite low compared to solid ammonium nitrate.

Because of the wide variety of soils to which these pasture recommendations will be applied, and of the extensive nature of the typical commercial livestock operation in Mississippi, particularly beef cattle, the pasture fertilizer recommendations are generally presented as a range instead of a single and more arbitrary figure.

The lower limit of the recommendation is estimated to be sufficient for plant establishment and (1) for reasonable yields of forage on soils well adapted to the particular pasture crop under consideration, (2) for periods of economic stress during which it is still necessary to maintain a reasonable supply of cheap forage, and (3) where acreage per animal unit is not a serious limiting factor.

The upper limit of the fertilizer recommendations continues to be the agronomic optimum and should be used where the (1) soil type, (2) management system, (3) type of livestock enterprise, and (4) economic trend are such as to justify the considerably higher yields of forage that result from its use.

For winter growing grass-legume combinations, the amount of nitrogen used and the time of application depend primarily upon when grazing is needed and upon the desired proportion of grass and legume. Although there is very little difference in the total season's production of forage, fall applications speed plant establishment, increase fall and winter

yields, and tend to provide a more favorable grass-legume ratio. For milking cows, lambs and other classes of livestock or system of managements where fall and winter grazing is important, and where danger of bloat exists, application of 30-60 lbs. N at planting time is recommended.

The yield of grass forages is greatly increased by application of nitrogen and, where weather conditions do not limit growth, excellent response is obtained to high rates of nitrogen; therefore, the most economical rate will depend upon temperature, availability of moisture, and the use made of the additional forage.

To increase the utilization of the nitrogen or to obtain a more favorable distribution of pasture production, split applications of nitrogen are recommended for both summer and winter grass pastures, with 60-120 pounds being applied each time.

For winter growing grass or grass-legume pastures that are seeded late and from which no fall or winter grazing can be expected the nitrogen application should not exceed 60 lbs. at seeding.

Except for coastal bermudagrass, where the last application may be as late as September 1, the last application of nitrogen to permanent summer pastures should be made no later than August 1, and two weeks earlier if anhydrous ammonia is used. Because of the frequency

of drought, mid-summer applications of nitrogen are generally less effective than applications made in the spring and early summer. For this reason more nitrogen should be applied in the spring than in summer season.

It may be economical to apply up to 200 pounds of nitrogen per acre to millet and sudangrass; 200 pounds to common Bermudagrass, Dallisgrass, and Bahiagrass, and 240 pounds to Coastal Bermudagrass pasture.

For summer temporary grazing crops, best response is obtained from nitrogen incorporated into the seedbed with phosphorus and potash prior to planting. Surface applications after each grazing or cutting are effective if rainfall is adequate.

Fall application of phosphorus or potash to pastures is recommended if these nutrients are necessary to establish forage seedlings in the fall. However, spring application is slightly more effective for spring and summer growth of perennial plants and those which come up in the spring. In general, fertilizers should be applied as close as practical to the time they are to be used by plants, therefore seasonal, annual applications are indicated in the following tables on forage and pasture crops. If phosphate and potash are applied only once in two years to permanent pastures the rate per application should be twice the annual rate.

Recommendations for Delta Pasture and Grain Crops

Pasture Crop	Recommended Varieties	Rate of Seeding lb. per Acre	Time of Planting	Fertilization, lbs./A. Annual Application, Except Lime.
Alfalfa	Buffalo and Delta	10-20 lbs.	Sept. 1-Oct. 15	Test soil for lime, phosphorus and potash needs.
Bermudagrass	Coastal (Irrigated)	20 bu. sprig	Nov. 1-May 1	180 lbs. N, 4 applications beginning June 1 for grazing. For hay, 300 lbs. N in split applications.
Bermudagrass-Clover	Clover, La. S-1	2 lbs.	Plant Clover Sept. 1-Oct. 15	Test soil for lime, phosphorus, and potash needs.
Fescue and Clover	Kentucky-31 Fescue La. S-1 White Clover	10 lbs. Fescue 1-2 lbs. Clover	Oct. 1-Nov. 1 Feb. 1-May 1	30 lbs. N at planting, 60 lbs. N Sept. 1 for winter grazing Test soil for lime, phosphate and potash needs.
Red Clover	Orbit, Kenland	10-15 lbs. seed alone or in small grains	Oct. 1-Nov. 1	Test soil for lime, phosphate, and potash.
White Clover	La. S-1	2-3 lbs. seed with grass	Oct. 1-Nov. 1	Test soil for lime, phosphate and potash.
Arrowleaf Clover	Meechee	12-15 lbs.	Oct. 1-Nov. 1	Test soil for lime, phosphate, and potash.
Sorghum-Sudan hybrids	All good commercial varieties	10 lbs. in rows	Apr. 15-June 15	60 lbs. N prior to planting. 60 lbs. N after each cutting.
Lespedeza	Korean, Climax or Summit	20-25 lbs. seed in small grains	Feb. 15-Mar. 15	Test soil for lime, phosphate and potash.
Grain Sorghum	DeKalb's C44B, E57, BR60, BR62; RS 610; Savannah	6 to 8 lbs. 38" to 40" rows	April 20-July 10	120 to 180 lbs. N, prior to planting. For second crop add 60 lbs. after first harvest.
Oats	Coker 242, Ora, More-grain, Delair, Midsouth	3 bu. for grazing 2½ bu. for grain	For grazing: early Sept. For grain: mid-Oct.	Grazing: 60 lbs. N at planting and 60 lbs. in Feb. Grain: 45 to 60 lbs. N Feb. 20-March 15.
Wheat	Ga. 1123, Knox, Bledsoe, Hadden, Atlas 66, Wakeland	1¼ bu. for grain 1½ bu. for grazing	Same as Oats	Same as for Oats.
Rye	Explorer, Elbon	1¼ bu. for grain 1½ bu. for grazing	Same as Oats	Same as for Oats.

Recommendations for Pastures in Hill Sections

Pasture Crop	Recommended Varieties	Time of Planting	Rate of Seeding per Acre	Fertilization, lbs./A Annual Fertilization ¹
WARM SEASON GRASSES (PERMANENT)				
Bahiagrass	Pensacola, Wilmington, (Argentine—South Mississippi only)	Feb.-April; or Aug.-Oct.	15 lbs./A	120 to 180 lbs. N in split appli- cations and 30 to 45 lbs. each of P ₂ O ₅ and K ₂ O. Total appli- cation in a 4-1-1 ratio.
Bermudagrass	Common	Feb.-May	2-5 lbs. seed	Same as for Bahiagrass.
	Coastal	Feb.-May	20 bu. of sprigs per acre	For Grazing: 120 to 240 lbs. N in split applications and 30 to 60 lbs. each of P ₂ O ₅ and K ₂ O. Total application in 4-1-1 ratio. For Hay: 200 to 300 lbs. N in split applications; 50 to 90 lbs. of P ₂ O ₅ ; 100 to 180 lbs. K ₂ O. Total application in a 4-1-2 ratio.
Dallisgrass	Domestic, imported	Feb.-April; Aug.-Oct.	10 lbs. (live seed)	Same as Bahiagrass.
Johnsongrass	Commercial	Feb.-May	15-25 lbs. (live seed)	Same as for Coastal bermuda grass.

COOL SEASON GRASSES (PERMANENT)

Tall Fescue	Kentucky-31, Kenwell, Alta	Aug.-Oct. 15	15 lbs.	30 to 140 lbs. N, split—fall and spring; 40 to 60 lbs. each of P ₂ O ₅ and K ₂ O in a 1:1 ratio.
Orchardgrass (North Miss. only)	Commercial	Aug.-Oct. 15	15 lbs.	Same as Tall Fescue

WARM SEASON GRASS-LEGUME MIXTURES (PERMANENT)

	As above		As above		Establishment: 60 to 100 lbs. of P_2O_5 and 30 to 50 lbs. K_2O in a 2:1 ratio.
Bamagrass, Bermudagrass, Dallisgrass with one of the following legumes:					
White Clover	Regal, La. S-1, or Tillman	Sept. 1-Oct. 15	1-3 lbs.		Maintenance: 30 to 60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio.
Crimson Clover	Chief, Auftauga or Frontier	Sept. 1-Oct. 15	25 lbs.		Same as above. For seed production add 0.5 to 1 lb. of boron.
Arrowleaf	Meechee or Yuchi	Sept. 1-Oct. 15	10-15 lbs.		Same as Crimson Clover.
Lespedeza	Kobe, Climax, or Summit	Feb.-April	20 lbs.		Establishment: 40-60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. Maintenance: 40 lbs. each of P_2O_5 and K_2O .
Johnsongrass with one of the following for hay:	Commercial	Feb.-May	15-25 lbs. (live seed)		
Alfalfa	Delta, Cody, Cherokee		15 lbs.		Establishment: 100 to 150 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. Maintenance: 60 to 80 lbs. P_2O_5 and 180 to 240 lbs. K_2O in a 1:3 ratio.
Red Clover	Orbit		10 lbs.		Same as with Alfalfa.
Wild Winter Peas	Commercial		30 lbs.		60 to 90 lbs. P_2O_5 and 120 to 180 lbs. K_2O in a 1:2 ratio, 120 lbs. N after peas mature.

Recommendations For Pastures In Hill Sections—(Continued)

Pasture Crop	Recommended Varieties	Time of Planting	Seeding per Acre	Fertilization, lbs./A annual Application ¹
WARM SEASON GRASSES (ANNUAL OR TEMPORARY)				
Millet	Gabi-1, Starr	Apr. 15-June 15	10 lbs. in rows 25 lbs. broadcast	120 lbs. N, split application, 60 lbs. P_2O_5 and 60 lbs. K_2O .
Sorghum-Sudan hybrids	Grazer-A, Haygrazer, Lindsey 77-F, MorSu, Sordan, Sweet Sioux, SX-12	Apr. 15-June 15	15 lbs. in rows 30 lbs. broadcast	120 to 180 lbs. N in split applications; 60 lbs. P_2O_5 and 60 lbs. K_2O .

COOL SEASON GRASS - LEGUME MIXTURES (ANNUAL OR TEMPORARY)

Annual Ryegrass with one of the following:	Gulf, Magnolia or Tetrablend		25 lbs.	0-60 lbs. N, 60-100 lbs. P_2O_5 and 30 to 50 lbs. K_2O in a 2:1 ratio at seeding time.
Arrowleaf Clover	Meechee		10 lbs.	
Crimson Clover	Autauga, Chief, Frontier		20 lbs.	Same as above.
Annual Ryegrass and wheat or oats with legume (as with ryegrass)	As above See wheat and oats		15 lbs. 90 lbs.	Same as above.
Small Grains and Legume (Use same as with ryegrass)	Oats, rye or wheat (See varieties under grasses)		90 lbs. of small grain	Same as above.

COOL SEASON GRASS - LEGUME MIXTURES (PERMANENT)

Tall Fescue or Orchardgrass (North Mississippi only)	Alta, Kentucky-31, Kenwell Commercial	Sept. 1-Oct. 15 Sept. 1-Oct. 15	10 lbs 10 lbs	Establishment: 60 to 100 lbs. of P_2O_5 and 30 to 50 lbs. of K_2O in a 2:1 ratio. Maintenance: 40 to 60 lbs. of P_2O_5 and K_2O in a 1:1 ratio
with				
White Clover	Regal, Tillman, or La. S-1	Sept. 1-Oct. 15	1-3 lbs.	

COOL SEASON GRASSES (ANNUAL OR TEMPORARY)

Annual Ryegrass	Gulf, Magnolia, Tetablend	Sept. 1-Oct. 15	20-30 lbs.	120 to 220 lbs. of N, split fall and spring; 80 to 100 lbs. P_2O_5 and 40 to 50 lbs. K_2O in a 2:1 ratio.
Rescuegrass	Lamont	Sept. 1-Oct. 15	30-40 lbs.	Same as Ryegrass.
Barley (Grain only)	Dayton, Harrison, Kenbar, and Decatur	Oct. 1-Nov. 15	1½ bu.	10 lbs. N at planting, 20 lbs. P_2O_5 and 20 lbs. K_2O at seed- ing. Topdress with 40 to 60 lbs. N about March 1.
Oats	Sumter, Midsouth, Moregrain, Carolee Cra,* Forager*	For Forage: Sept. 1-Oct. 1 For Grain: Oct. 1-Nov. 15	For Forage: 120 lbs. (4 bu.) For Grain: 2½ bu.	Same as Ryegrass. Same as for Barley.
Rye	Elbon, Explorer	Same as Oats	For Forage: 80 lbs. For Grain: 2½ bu.	Same as Ryegrass. Same as for Barley.
Wheat	Knox, Acc, Georgia 1123, Vermillion, Knox 62, Bledsoe, Wakeland	Same as for Oats	For Forage: 90 lbs. For Grain: 1¼ bu.	Same as Ryegrass. Same as for Barley.

*For Forage only.

Recommendations For Pastures In Hill Sections—(Continued)

Pasture Crop	Recommended Varieties	Time of Planting	Seeding per Acre	Fertilization, lbs./A annual Application ¹
LEGUMES				
Alfalfa (Hay)	Delta, Cherokee, Cody	Aug. 15-Oct. 15	15-25 lbs.	Establishment: 120 to 160 lbs. each of P_2O_5 and K_2O in a 1:1 ratio and 1.5 lbs. boron. Maintenance: 60-80 lbs. P_2O_5 and 180 to 240 lbs. K_2O in a 1:3 ratio and add 1 lb. boron.
Arrowleaf Clover	Meechee	Sept.-Oct. 15	10 lbs.	60 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. For seed production add 0.5 to 1.0 lb. boron. Same as for Arrowleaf Clover.
Austrian Winter Peas	Commercial	Sept.-Oct. 15	50 lbs.	
Crimson Clover	Autauga, Chief, Frontier	Sept.-Oct. 15	20-30 lbs.	Same as for Arrowleaf Clover.
Lespedeza (Annual)	Climax, Kobe, Summit	Feb.-April 15	25 lbs.	Same as for Arrowleaf Clover.
Sericea (Perennial)	Sarella, Commercial	Feb.-June	30-40 lbs.	
Red Clover (Hay)	Orbit	Sept. 1-Aug. 15 Mar.-April 15	10 lbs.	Establishment: 60 to 100 lbs. each of P_2O_5 and K_2O in a 1:1 ratio. Maintenance: 50 lbs. P_2O_5 and 100 lbs. K_2O in a 1:2 ratio. Same as for Arrowleaf Clover.
Rough Pea	Commercial—also known as Singletary, Caley and Wild Winter Peas	Sept. 1-Oct. 15	40 lbs.	
Vetch	Warrior	Sept. 1-Oct. 15	30 lbs.	Same as for Arrowleaf Clover.
White Clover	La. S-1, Regal, Tillman	Sept. 1-Oct. 15	2-3 lbs.	Same as for Arrowleaf Clover.

¹For legumes and grass-legume combinations, soils should be limed initially to establish and subsequently to maintain a pH of 6.0 to 7.0; for non-legumes the pH range should be 5.5 to 6.5. Refer to section on Soil pH and Liming. Unless indicated otherwise fertilizer recommendations are for grazing. When forage and pasture crops are harvested repeatedly from the same area for hay or silage instead of being grazed, the rate of potash should be increased to about twice that recommended for grazing.

Recommendations for Lawns and Similar Turf Areas

Grass	Recommended Varieties	Method of Planting	Rate of Planting	Fertilization per 1000 sq. ft. per Yr. ¹
Bahia	Argentine, Pensacola Paraguayan, Wilmington	Seed	5 lb./1000 sq. ft.	6 lbs. nitrogen 2 lbs. P ₂ O ₅ 4 lbs. K ₂ O split into 4 applications
Bermudagrass	Common Tiflawn, Ormond, Tifway, Tifdwarf, Tex-turf 10	Seed Sprig or plug	2 lbs./1000 sq. ft. Sprig or plug 6-12 ins. apart on 6-12 in. rows	6-8 lbs. nitrogen 2 lbs. P ₂ O ₅ 3-4 lbs. K ₂ O, split into 4 applications
Carpet	Common	Seed	5 lb./1000 sq. ft.	2-3 lbs. nitrogen 1 lb. P ₂ O ₅ 1-2 lbs. K ₂ O, split into 2-3 applications Same as carpet
Centipede	Common, Oklawaha	Seed Sprig or plug	4 oz./1000 sq. ft. Plug or plug 6-12 ins. apart on 6-12 in. rows	
Fescue	K-31, Kenwell	Seed	7-10 lbs./1000 sq. ft.	4 lbs. nitrogen (2 in fall, 2 in spring) 2 lbs. P ₂ O ₅ and 4 lbs. K ₂ O
Ryegrass	Gulf, Magnolia	Overseed permanent lawns	3-10 lb./1000 sq. ft.	1 lb. nitrogen in January if needed
St. Augustine	Common	Sprig or plug	Sprig or plug 6-12 ins. apart on 6-12 in. rows	Same as bahia
Zoysiagrass	Emerald, Matrella, Meyer	Sprig or plug	Sprig or plug 6 ins. apart on 6 in. rows	Same as bahia

¹When establishing a new lawn incorporate 2-3 lbs. of N; 4-5 lbs. of P₂O₅ and 2-3 lbs. of K₂O per 1000 sq. ft. into the seedbed prior to planting.

Horticultural Crops

VEGETABLE VARIETY AND FERTILIZER RECOMMENDATIONS

The variety and fertilizer information supplied here is based on tests throughout Mississippi. The varieties listed are suitable for both home garden and commercial purposes unless otherwise designated. These fertilizer rates are recommended primarily for fresh market crops and maximum rates on soils low in phosphorus and potassium. The use of the Mississippi Soil Test-in Service is recommended for all soils used for commercial production of vegetable crops grown for processing. This is especially true where the soil reaction (pH) is not known, since many vegetable crop failures are due to improper liming.

CROP	VARIETY	pH	N	Fertilizers pounds per acre	
				P ₂ O ₅	K ₂ O
Asparagus	Mary Washington*	6.0-7.0	50	100	100
				After cutting season topdress with	
			25	50	50
Beans and Peas		5.8-7.0	50	100	50
Bush Lima				Sidedress in full bud stage with	
Small seeded	Dixie Butter Pea, Thaxter Early Thorogreen, Nemagreen**		32	0	0
Large Seeded	Fordhook 242*				
Colored Seeded	Jackson Wonder, Dixie Butter Pea, Speckled				
Pole type lima	Carolina Sieva, Willow Leaf, Florida Speckle				
Bush Snap	Contender (oval), Highlander Provider* (round) Slenderwhite***, Cascade***, Tenderette***, Tenderwhite***, Bush Blue Lake 274***				
Pole snap	Kentucky Wonder, Blue Lake				
English Pea	Little Marvel*, Coronet*** Freezer 69***, Freezer 640***				
Southern Pea	Mississippi Crowder, Mississippi Silver** Bunch Purple Hull***, Dixilee***	5.8-7.0	20	40	40

CROP	VARIETY	pH	N	P ₂ O ₅	K ₂ O
Broccoli	Coastal, Prima, Spartan	5.5-6.5	75	100	100
				20-40 lbs. borax	
				When heads begin to	
				form sidedress with	
			32	0	0
Cabbage	Round Dutch, Early Jersey Wakefield*				
Cauliflower	Snowball-E or Snowball-M				
Collard	Vates***, Morris Heading***				
Mustard	Florida Broadleaf	5.5-6.5	48	48	48
	Southern Giant Curled			Sidedress with	
			32	0	0
Radish	Cherry Belle, Scarlet Globe, White Icicle (long)				
Turnip	Purple Top White Globe, Just Right, Seven Top, Shogoin (greens)				
Beet	Perfected Detroit, Garnet	6.0-7.0	75	100	100
				Sidedress with	
Carrot	Gold Spike, Imperator		32	0	0
	Chantenay, Danver 126***				
Spinach					
Savoy	Bloomsdale, Long Standing, Old Dominion				
Smooth	Viroflay, Hybrid No. 7 Chesapeake Hybrid				
Cantaloupe	Edisto, Hales Best	5.5-6.5	40	80	80
	No. 36			When plants begin to	
				run sidedress with	
			30	30	30
Cucumber					
Slicing	Ashley, Long Green				
Pickling	Piccadilly***, Pixie***, Ohio MR 17***, Southern Cross*** SMR58***				
Squash	Early Summer, Crookneck, White Bush Scallop, Zucchini				
Watermelon	Blackstone, Verona, Charleston Gray, Garrisonian				

Vegetable Varieties Continued

CROP	VARIETY	pH	N	Fertilizers pounds per acre	
				P ₂ O ₅	K ₂ O
Eggplant	Florida Market, Black Beauty	5.5-6.0	75	100	100
			32	Sidedress with 0	0
Irish Potato	Red LaSoda***, Superior*** LaChipper***				
Pepper, Bell	Early Calwonder, Keystone Resistant Giant, Emerald Giant				
Pepper, Hot	Long Red Cayenne	5.5-6.0	40	80	80
				Sidedress with	
Pepper, Pimento	Trueheart Perfection, Mississippi Nemaheart**		30	30	30
Tomato Red	Marion, Floradel, Manapal, Chico Grande***	6.0-7.0	60	120	60
			40	Sidedress with 40	40
Pink	Bradley				
Greenhouse Production	Tuckcross K** or O, Mana- pal, Mo. Hybrid 520, Florida-Hawaii F**			Based on soil testing	
Lettuce Leaf Head	Bibb, Salad Bowl Great Lakes	6.0-7.0	75	100	100
				Sidedress with	
Greenhouse	Bibb, Grand Rapids		32	0	0
Okra	Emerald, Clemson Spineless***	6.0-6.5	30	40	40
			20	Sidedress with 0	0
Onion	Granex, Grano, Multiplier*	6.0-7.0	50	100	100
			50	Sidedress with 0	0
Sweet Corn	Royal Gold, Golden Security, Illinichief Super Sweet, Seneca Brave	5.5-6.5	30	40	40
			64	Sidedress with 0	0
Sweet Potato	Rose Centennial***, Centennial***, Gold Rush***, Unit I Porto Rico	5.5-6.5	40	80	80

*Home Garden Only

**Where nematodes are a problem

***Suitable for processing

FERTILIZERS FOR FRUIT CROPS

Recommendations are for annual applications on soil of average fertility where clean cultivation is practiced in the summer. Soil samples or leaf analyses in commercial orchards may indicate need for different ratios. Commonly in the Delta Area, only nitrogen fertilizer is needed.

Tree Fruits	Grade	Pounds per tree per year of age
Applied under tree branches before growth begins in Spring.		
Apples, Pears	12-16-16	1/2
If trees blight seriously, nitrogen fertilizer can be reduced or omitted. Maximum rates should be reached at 15-20 years.		
Peaches, Plums	12-16-16	1/2
	33-0-0	1/4
Apply two-thirds of N Fertilizer before growth begins and one-third in June or July. Maximum rates should be reached at 6 to 10 years.		
Pecans	12-16-16	1-1 1/2

Small Fruits	Grade	Pounds per acre
Strawberries (Central and North Mississippi)		
February	12-16-16	150-250
June	12-16-16	150-250
September	12-16-16	150-250
In South Mississippi apply 12-16-16 at rate of 3-5 pounds per 100 feet of row before setting plants and 1 to 3 pounds per 100 feet of row in January.		1-2 lbs. per vine
Blackberries, Dewberries, Raspberries		
February	12-16-16	150-250
June	12-16-16	150-250
	33-0-0	150-250
Grapes (Mature vines) February	12-16-16	200-600

Varieties

Apples (in order of ripening): Early Harvest, Lodi, Williams Early Red, Cauley, Golden Delicious, Red Delicious, Stayman Winesap.

Crab Apples: Transcendent, Dolgo, Yellow Siberian.

Strawberries: South Mississippi—Dabreak Headliner, Klonmore.

Elsewhere — Pocahontas, Dixieland, Blakemore.

Pears (in order of ripening): Avres, Orient, Garber, Morgan, Waite, Kieffer.

Plums: Bruce, Burbank, Methley, Munson, America, Santa Rosa.

Peaches (in order of ripening): Central and North Mississippi—Earligold, Earlired, Dixired, Dixigem, Redhaven, Triogem, Halehaven, Loring, Sullivans Early Elberta, Georgia Belle, Elberta, Afterglow.

South Mississippi—June Gold, Hiland,

Maygold, Sam Houston, Keystone, Sun-high, Southland, July Elberta, Redskin, Afterglow.

Pecans: Stuart, Desirable, Farley, Lewis, Elliot.

North Mississippi (trial only) Owens.

Blackberries: Williams (semi-erect), Flint (semi-erect), Brazos (semi-erect), Thornless Boysen (trailing).

Raspberries: Sodus (purple), Sunrise (red), Morrison (black), Golden Queen (yellow).

Muscadines: Black — Magoon,* Hunt, Southland,* Thomas, Bountiful,* Chief,* Creek.

Bronze — Dearing,* Topsail, Scuppernong, Higgins.

*At least one of these pollinator vines must be included with all plantings.

Bunch Grapes: Concord or Champanel (blue), Delaware or Catawba (red), Niagara (white).

FERTILIZER RECOMMENDATIONS FOR ORNAMENTALS

Soil tests are recommended; if they are not available, then use the following:

Plant	Applications		Fertilizer	Rate*
	Number	Time		
Shade Trees	1	Oct. to March	13-13-13	1 lb./i i. trunk diameter, 3 ft. high
Shrubs and Flowers	1	Spring	13-13-13	1 to 2 lbs./100 sq. ft.

(Fertilize trees at least every three years. Distribute in holes 12 inches deep, spaced evenly within the branch spread and use at least 20 holes per inch of tree diameter.)

(For lone or specimen shrubs, use $\frac{1}{4}$ to $\frac{1}{2}$ lb. per plant.)

For commercial greenhouse or nursery crops or for special plants, write for details.

*Equivalent amounts of N-P-K may be applied by other materials.

TUNG

Varieties: Isabel (L-2), Folsom (L-47), Gahl (L-51), La Crosse (F-99), and Lampton (F587).

Fertilization: Apply fertilizer to non-bearing orchards as shown in Table 1. Fertilize newly planted trees soon after growth starts, spreading the mixture evenly in bands about 6 inches wide, the inner edges of the bands about 12 inches from the tree trunks. In the second and subsequent years after planting, spread fertilizer evenly under the spread of the branches shortly before growth starts.

Fertilize bearing trees shortly before they blossom, adjusting rates to the potential yield as shown in Table 2. When annual leaf analyses indicate that the elements are critical or out of the optimum range, then specific recommendations can be made by personnel of the Experiment Station, or the U.S.D.A. Tung Laboratory.

Usually it is more economical to apply the nitrogen as anhydrous ammonia, aqua ammonia, or ammonium nitrate and the phosphorus and potassium as 0-10-30 or superphosphate and muriate of potash than to apply a complete mixed fertilizer. When a complete mixed fertilizer is used the ratio of elements should be 2-1-2; a 16-8-16 formula is manufactured for this purpose. If inadequate zinc is indicated by leaf analysis or symptoms, apply 2 ounces of commercial zinc sulphate per tree under 5 years of age. For older trees, apply 4 ounces. If magnesium or calcium is deficient, apply dolomitic lime to bring the pH up to 5.5 or 6.0. After the trees are large enough for the branches to nearly meet in the tree row, the fertilizer may be applied in bands on each side of the tree row. All solid fertilizers should be incorporated in the soil by cultivation.

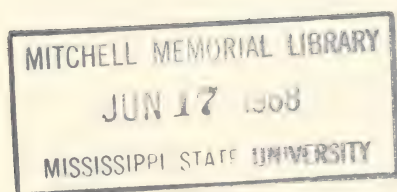
Table 1. Fertilizer requirements of nonbearing tung orchards.

Years in the orchard	Fertilizer ratio	Amount pounds/tree		
		N	P ₂ O ₅	K ₂ O
Newly planted	1-2-1	.05	.10	.05
One year	1-2-1	10	.20	.10
Two years	1-2-1	20	.40	.20
		pounds/acre		
Three years	2-1-2	50	25	50
Four years	2-1-2	60	30	60

Table 2. Fertilizer requirements of bearing tung orchards.

Potential production tons/acre	pounds/acre		
	N	P ₂ O ₅	K ₂ O
0 to 1	75	25	75
1 to 2	100	50	100
2 or more	130	60	160

Mississippi Cotton Variety Tests Delta And Hill Sections, 1968



**Mississippi State University
AGRICULTURAL EXPERIMENT STATION**

HENRY H. LEVECK, Director

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MISSISSIPPI COTTON VARIETY TESTS FOR 1968

IN THE DELTA

By ROBERT R. BRIDGE, WILLIAM R. MEREDITH, JR.,
and JAMES F. CHISM¹

The cotton variety picture is changing rapidly as shown by the results presented in this report. Since 1962, several new varieties have been placed on the market. Deltapine Smooth Leaf is the only variety in the 1967 tests that was tested prior to 1962. In 1967: Deltapine 45A, Coker 201, Deltapine 15A, and Coker 413 were released as new varieties. Stoneville 508 and Deltapine 16 are new varieties being released for 1968 planting.

The present emphasis is on quality cotton varieties, since the future of cotton depends upon the production of quality varieties. One of the most important decisions facing the cotton grower is the selection of an appropriate variety, since a major factor in the yield and quality of the harvested cotton crop is the variety of cotton planted.

The yield and quality of a variety is fixed by the genotype or inherent potential of the plants that make up any given variety. Under ideal growing conditions and the most careful ginning, the quality of the variety cannot exceed the upper limits imposed by heredity.

Most cotton varieties are bred for specific soil and climatic conditions, therefore it is necessary for the producer to select a variety adapted to his specific area. The medium staple varieties now being grown in the Mississippi Delta are

considered to be widely adapted. While these varieties are not suited for unlimited areas of growth they perform more consistently in different environments than some of the new high quality varieties and the western varieties. Some of these quality varieties appear to be later in maturity, less adaptable, lower in yield, and have a lower lint percent than our standard varieties. Only through continued testing at several locations over a period of years will we be able to predict, with any measure of success, the performance of these varieties.

In 1967 the cotton variety testing program at Stoneville was changed so that information on these quality varieties could be obtained. This report shows the performance of several varieties that have not been tested in the past. These variety tests results are published to act as guides in the selection of varieties possessing the best balance of productivity and fiber quality characteristics.

Four Locations

Cotton variety trials were conducted by the Delta Branch Experiment Station in 1967 at four locations; The Delta Station at Stoneville, Arnold Plantation near Tunica, Schaefer Plantation near Yazoo City, and the Mitchner Plantation near Sumner.

Current strains of 16 varieties were grown at all locations in 1967. Thirteen varieties grown at Stoneville and Tunica are included in a cooperative beltwide variety testing program. Each variety test was planted in a randomized complete block design with six replications.

At Tunica (Table 1) the test was planted on May 11, which is about a week later than normal. Yields ranged from 780 to 1087 pounds of lint per acre. with

¹Plant breeder, Delta Branch Experiment Station, Mississippi Agricultural Experiment Station, Stoneville, Mississippi; Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Stoneville, Mississippi; and Research Associate, Delta Branch Experiment Station, Mississippi Agricultural Experiment Station, Stoneville, Mississippi. This report is based upon results from cooperative research conducted by the Mississippi Agricultural Experiment Station and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

an overall average yield of 934 pounds of lint per acre. The average fiber length and strength at Tunica was higher than that of any other test site. The five highest yielding varieties at Tunica (Deltapine 16, Deltapine 45A, Coker 201, Hancock, and Stoneville 213) also had the highest yield when averaged over all locations.

At Sumner (Table 2) variety trials were conducted for the first time at this location. The test was planted on April 29, but due to delayed maturity caused by cool wet weather, and days of low light intensity, the first harvest was not made until November 6. The average yield of all varieties in this test was 1315 pounds of lint per acre. This lint yield was 300 to 400 pounds higher than that of any other test. The test at Sumner was damaged by the freeze causing some loss in production. The yields ranged from 1087 to 1514 pounds per acre with Deltapine 16, Coker 201, Deltapine 45A, McNair 1032 and Stoneville 213 being the five highest yielding varieties. Fiber length of all varieties was good.

At Yazoo City (Table 3) the planting on May 9 was about two weeks later than usual. The total lint yield ranged from 819 to 1132 pounds of lint per acre, with an overall average of 1001 pounds of lint per acre. The five highest yielding varieties at Yazoo City were Coker 201, Stoneville 213, Deltapine 16, Deltapine 15A and Stoneville 7A. Lint percentages were somewhat higher than usual and the micronaire index showed the fiber to be coarser than that of other tests. The fiber length and strength was also lower than usual.

At Stoneville (Table 4) the test was planted on April 27 which is about the normal time for planting at Stoneville. The high degree of Verticillium wilt is possibly part of the cause for the lower

yields. The average yield of 904 pounds of lint per acre was the lowest of all four tests. The total lint yield ranged from 683 to 1040 pounds of lint per acre. The average fiber length of 1.06 inches as measured on the digital fibrograph was also the lowest of all tests. The highest yielding varieties at Stoneville were Deltapine 16, Deltapine 45A, Hancock, Stoneville 213, Mo61-47OF, and Stoneville 7A.

Averages of All Locations

Table 5 gives the average performance of all varieties at four locations. The average yield at all locations was 1058 pounds of lint per acre. The five highest yielding varieties averaged 1137 pounds compared to 950 pounds of lint per acre for the seven lowest yielding varieties.

The seven lowest yielding varieties, with the exception of Paymaster 54B, usually had longer and stronger fiber than the other varieties. The six highest yielding varieties; Deltapine 16, Deltapine 45A, Coker 201, Hancock, Stoneville 213, and Stoneville 7A ranked in the top six at most locations. The micronaire value for most varieties was lower than usual; however, for some varieties at Yazoo City it was high.

The data presented show that varieties play a very important part in determining the yield and quality of cotton. In choosing a variety, care should be taken to choose one that produces the greatest length and highest strength possible without sacrificing significant amounts of yield and performance consistency.

Classing was done by the Staple Cotton Cooperative Association in Greenwood, Mississippi. Fiber properties data were determined by the fiber laboratory of Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, at Knoxville, Tennessee.

Table 1: Results 1967 Variety Test - Tunica, Mississippi

Variety	Lint per acre Total	Per- cent first pick	Per- cent lint	Seed index	Boll size grams	Fiber properties						
						Classer 1/32 in.	Length 2.5%	50%	Strength T _l gram/tex	Elon- gation E _l	Micro- naire	
Hancock	1087	940	86	38.3	12.8	6.67	35.0	1.10	.51	18.30	7.18	4.05
Deltapine 16	1010	847	84	37.3	11.5	6.26	36.5	1.16	.54	19.15	9.15	4.20
Coker 201	1005	852	85	37.1	12.6	6.81	37.0	1.17	.55	19.24	6.80	4.23
Deltapine 45A	995	841	85	36.9	11.9	6.11	36.5	1.15	.56	19.55	8.89	4.21
Stoneville 213	969	761	79	36.4	11.9	6.02	35.5	1.09	.50	18.81	7.64	4.51
Paymaster 543	947	854	90	35.9	12.2	6.86	32.0	1.00	.51	17.25	9.55	4.11
Deltapine Smooth Leaf	935	724	77	36.0	10.9	5.91	36.0	1.15	.54	19.27	9.66	4.20
Deltapine 15A	931	690	74	37.7	10.6	5.73	36.0	1.12	.52	18.67	9.36	3.97
Mo 61-470F	925	730	79	35.6	14.7	7.12	37.0	1.17	.58	21.03	9.42	4.40
NI 9603	925	785	85	34.6	13.0	6.62	37.0	1.21	.59	22.39	6.63	4.07
Stoneville 7A	914	674	74	36.0	11.6	5.89	35.5	1.14	.55	18.48	6.87	4.31
Acala 1517D	912	766	84	34.2	13.8	6.89	37.5	1.23	.61	24.64	7.14	4.10
Coker 413-68	892	754	85	35.4	12.0	6.18	37.5	1.18	.54	19.74	6.61	3.95
McNair 1032	868	628	72	33.9	13.0	6.28	36.0	1.15	.56	20.53	7.52	4.10
Stoneville 9008	847	614	72	36.5	11.0	5.81	35.0	1.14	.50	19.65	8.72	3.50
Stoneville 508-9117	780	613	79	34.6	12.8	6.69	38.5	1.21	.53	19.07	8.11	3.75
C.V.	10.43	13.80		1.88	3.91	3.05		2.09		1.82	6.15	4.41
L.S.D. .05	111	112		1.44	1.02	0.41		0.051		0.77	1.06	0.39
L.S.D. .01	148	148		1.99	1.42	0.57		0.071		1.06	1.47	0.53

Planted: May 11, 1967

Harvested: October 24 and November 15, 1967

Table 2: Results 1967 Variety Test - Summer, Mississippi

Variety	Fiber properties											
	Lint Per Acre Total	Per- cent first pick	Per- cent lint	Seed index	Boll size grams	Length			Strength T ₁ gram/tex	Elon- gation E ₁	Micro- naire	
						Classer 1/32 in.	2.5%	50%				
Deltapine 16	1514	1347	89	38.6	11.1	6.17	36.5	1.15	.53	17.82	9.73	4.41
Coker 201	1510	1342	89	40.1	11.7	6.49	36.5	1.13	.52	17.23	7.69	4.76
Deltapine 45A	1479	1274	86	39.2	10.8	5.73	34.0	1.11	.53	18.14	9.22	4.22
McNair 1032	1430	1172	82	37.1	11.5	5.82	34.0	1.11	.53	18.40	8.20	4.63
Stoneville 213	1415	1221	86	38.4	11.5	5.90	35.0	1.12	.52	17.32	8.51	4.59
Hancock	1397	1242	90	39.5	12.4	6.53	34.0	1.09	.50	17.66	7.55	4.53
Stoneville 7A	1391	1137	82	38.6	11.4	5.81	35.0	1.12	.52	16.98	8.09	4.43
Deltapine Smooth Leaf	1350	1153	85	38.3	10.2	5.60	35.0	1.17	.55	17.90	10.06	4.36
Deltapine 15A	1279	1058	83	39.2	9.9	5.41	35.0	1.12	.51	17.85	9.96	4.01
Coker 413-68	1276	1131	88	37.4	11.8	5.93	36.5	1.19	.55	18.51	7.63	4.04
Acala 1517D	1254	1110	88	35.0	13.6	7.01	37.0	1.23	.60	21.82	7.68	4.17
Paymaster 54B	1190	1087	91	36.4	11.8	6.73	30.5	0.97	.46	16.11	9.75	4.46
Mo 61-470F	1175	1016	86	36.4	14.5	6.45	36.5	1.16	.55	19.12	10.04	4.56
Stoneville 508-9117	1164	1007	86	36.0	12.2	6.01	38.0	1.22	.55	18.69	8.45	3.73
Stoneville 9008	1133	910	80	37.7	10.6	5.49	36.0	1.14	.48	19.04	9.43	3.52
NNM 9608	1087	916	84	35.9	12.8	6.49	36.5	1.21	.57	20.34	6.59	4.36
C.V.	7.29	9.88		1.72	4.02	2.93		1.84		3.12	4.58	3.57
L.S.D. .05	110	128		1.39	1.00	0.38		0.045		1.22	0.85	0.33
L.S.D. .01	146	170		1.92	1.39	0.53		0.062		1.68	1.17	0.45

Planted: April 29, 1967

Harvested: November 6 and November 16, 1967

Table 3: Results 1967 Variety Test - Yazoo City, Mississippi

Variety	Fiber properties											
	Lint per acre		Per- cent first pick	Per- cent lint	Seed index	Boll size grams	Length			Strength T ₁ gram/tex	Elon- gation E ₁	Micro- naire
	Total	First pick					Classer 1/32 in.	2.5%	50%			
Coker 201	1132	879	78	41.7	11.5	5.86	34.5	1.08	.51	17.47	7.93	5.14
Stoneville 213	1117	381	79	39.4	11.5	5.75	34.0	1.06	.50	17.61	8.64	5.15
Deltapine 16	1114	805	72	40.2	10.7	5.76	35.5	1.09	.53	17.76	10.39	4.80
Deltapine 15A	1099	794	72	42.2	9.4	5.02	34.5	1.04	.50	17.56	10.48	4.67
Stoneville 7A	1094	832	76	39.6	11.2	5.70	35.5	1.06	.51	17.86	7.67	5.07
Deltapine 45A	1079	822	76	40.8	10.3	5.36	34.0	1.05	.52	17.74	9.30	5.00
Deltapine Smooth Leaf	1067	783	73	40.3	9.6	5.35	34.0	1.06	.51	17.71	10.74	5.01
McNair 1032	1063	752	71	40.2	11.2	5.51	34.0	1.03	.49	18.39	8.47	5.18
Hancock	1033	822	79	40.8	12.7	6.22	34.5	1.06	.52	17.50	8.28	4.96
Coker 413-68	970	750	77	39.9	11.0	5.55	35.5	1.10	.54	19.19	7.55	4.70
Acala 1517D	926	708	76	35.7	14.1	6.42	37.5	1.16	.59	21.78	7.73	4.61
Mo 61-470F	901	677	75	38.1	14.2	5.98	34.5	1.08	.54	18.41	10.07	4.89
Stoneville 9008	901	650	72	39.3	9.5	5.02	36.5	1.10	.50	18.06	9.59	3.64
Stoneville 508-9117	889	693	78	37.8	11.8	5.74	36.5	1.16	.56	18.18	8.79	4.10
NN 9608	821	602	73	36.8	13.1	6.00	36.5	1.15	.59	20.81	7.30	4.77
Paymaster 54B	819	662	81	38.5	11.6	6.41	31.5	0.90	.46	16.65	9.68	4.88
C.V.	6.57	5.89		1.43	2.65	4.42		1.97		2.74	4.94	3.72
L.S.D. .05	75	51		1.21	0.65	0.54		0.045		1.07	0.94	0.38
L.S.D. .01	100	67		1.67	0.90	0.75		0.062		1.48	1.29	0.52

Planted: May 9, 1967

Harvested: October 20 and November 9, 1967

Table 4: Results 1967 Variety Test - Stoneville, Mississippi

Variety	Fiber properties											
	Lint per acre Total	Per- cent first pick	Per- cent lint	Seed index	Boll size grams	Length		Strength T ₁ gram/tex	Elon- gation E ₁	Micro- naire		
						Classer 1/32 in.	2.5%					
Deltapine 16	1040	881	85	39.1	9.7	5.21	35.5	1.09	.49	19.44	9.46	3.90
Deltapine 45A	1004	829	82	38.9	10.7	5.31	35.0	1.06	.50	18.72	8.35	3.98
Hancock	991	893	90	37.3	10.7	6.18	34.0	1.00	.45	17.27	7.75	3.75
Stoneville 213	984	856	87	38.6	10.4	4.95	35.0	1.04	.47	17.65	7.80	4.06
Mo 61-470F	944	854	90	35.6	12.6	6.29	34.5	1.06	.48	19.89	8.47	3.88
Stoneville 7A	939	759	81	39.1	10.2	4.83	34.0	1.06	.48	17.57	6.78	4.02
McNair 1032	932	804	86	35.9	10.6	5.20	33.5	1.01	.48	18.83	7.56	3.78
Stoneville 9008	920	762	83	39.0	10.1	5.36	35.5	1.09	.47	19.42	9.03	3.55
Deltapine 15A	911	762	83	40.1	9.1	4.96	34.5	1.02	.44	18.75	9.46	3.82
Deltapine Smooth Leaf	894	755	84	37.8	9.0	5.20	35.0	1.09	.50	18.95	9.33	3.68
Coker 201	878	781	89	37.0	10.7	5.72	34.0	1.06	.48	18.56	7.57	3.86
Stoneville 508-9117	873	741	85	36.9	10.6	5.62	36.5	1.12	.50	19.65	8.30	3.48
NM 9608	869	695	80	36.2	12.0	6.16	37.0	1.10	.50	21.32	6.67	3.94
Paymaster 54B	842	760	90	36.7	11.1	6.10	32.0	0.90	.44	16.77	9.20	3.83
Acala 1517D	759	626	82	34.8	12.4	6.08	36.0	1.14	.54	21.72	7.18	3.69
Coker 413-68	683	574	84	35.7	10.8	5.35	35.5	1.11	.49	19.55	6.83	3.55
G.V.	7.01	7.94		1.86	3.42	4.35		1.77		2.45	4.29	3.84
L.S.D. .05	73	70		1.48	0.78	0.51		0.040		0.99	0.74	0.39
L.S.D. .01	96	91		2.05	1.07	0.71		0.055		1.37	1.03	0.54

Planted: April 27, 1967

Harvested: October 3 and October 25, 1967

Table 5: Average performance of 16 varieties at four Delta locations in 1967

Variety	Lint per acre		Per- cent first pick	Per- cent lint	Seed index	Boll size grams	Fiber properties					Strength T ₁ gram/tex	Elon- gation E ₁	Micro- naire
	Total	First pick					Length Classer 1/32 in.	2.5%	50%					
Deltapine 16	1169	970	83	38.8	10.7	5.85	36.0	1.12	.52	18.54	9.68	4.32		
Deltapine 45A	1139	941	83	38.9	10.9	5.63	34.8	1.09	.53	18.53	8.94	4.35		
Coker 201	1131	963	85	38.9	11.6	6.22	35.5	1.11	.51	18.12	7.49	4.49		
Hancock	1127	974	86	38.9	12.1	6.40	34.4	1.06	.49	17.68	7.69	4.32		
Stoneville 213	1121	929	83	38.2	11.3	5.65	34.8	1.03	.50	17.85	8.14	4.57		
Stoneville 7A	1084	850	78	38.3	11.1	5.55	35.0	1.09	.51	17.72	7.35	4.45		
McNair 1032	1073	839	78	36.7	11.5	5.70	34.4	1.07	.51	19.03	7.93	4.42		
Deltapine Smooth Leaf	1061	854	80	38.1	9.9	5.51	35.0	1.11	.52	18.45	9.94	4.31		
Deltapine 15A	1055	826	78	39.8	9.7	5.28	35.0	1.07	.49	18.20	9.81	4.11		
Mo 61-470F	986	819	83	36.4	14.0	6.46	35.6	1.11	.53	19.61	9.50	4.43		
Acala 1517D	962	802	83	34.9	13.4	6.60	37.0	1.19	.58	22.49	7.43	4.14		
Coker 413-68	957	802	83	37.1	11.4	5.75	36.2	1.14	.53	19.24	7.15	4.06		
Stoneville 9008	950	734	77	38.1	10.3	5.40	35.7	1.12	.49	19.04	9.19	3.55		
Paymaster 54B	949	841	89	36.8	11.7	6.52	31.5	0.94	.46	16.69	9.54	4.32		
Stoneville 508-9117	926	763	82	36.3	11.8	6.01	37.4	1.17	.53	18.89	8.41	3.76		
NM 9608	925	749	81	35.9	12.7	6.31	36.7	1.16	.56	21.21	6.79	4.28		

COTTON TESTS IN HILL SECTION

Fifteen cotton varieties were tested at all Hill Section locations in 1967. Varieties previously tested but omitted this year included Auburn 56, Auburn M, Coker 3903; Deltapine 5481, Empire WR 61, and Pennington Hy-Bee.

Five varieties were tested for the first time. These were: Hancock, recently released by the Tennessee Agricultural Experiment Station; Mo-61-470F, an experimental variety from the Missouri Agricultural Experiment Station; Deltapine 16, recently released by Delta and Pine Land Co.; and Stoneville 508, recently released by Stoneville Pedigreed Seed Company.

Successful tests were grown at the following locations: Central Station, State College; North Mississippi Branch Experiment Station, Holly Springs, one on hill land and one on bottom land on the farm of Mr. C. C. Moore; Pontotoc Branch Experiment Station, Pontotoc, in the flatwoods section; Blackbelt Branch Experiment Station, Brooksville; Brown Loam Branch Experiment Station, Raymond; and Coastal Plain Branch Experiment Station, Newton.

Variety tests at two locations were failures. The test at Northeast Mississippi Branch Experiment Station, Verona, was abandoned because of severe flooding and stand reduction in June. The test on the Pontotoc Ridge at the Pontotoc Branch Experiment Station, Pontotoc, was severely damaged by an early freeze on November 5 and was abandoned.

Weather conditions throughout the Hill section were generally unfavorable for cotton production. Early spring was wet and cool and stands were reduced sufficiently to require some replanting at Raymond and Holly Springs (both tests).

June was dry and hot and the late summer was wet and cool. Harvesting conditions were good throughout the Hill section except that a freeze on November 5 caused serious losses in all tests from State College northward. This freeze caused abandonment of one test at Pontotoc and damaged yields an estimated 10-50% at other locations in the northern part of the Hill section.

Boll weevils reached seriously damaging populations at most locations during the cool, wet weather of July and August. Bollworms also caused serious damage during this period at some locations.

Performance data for the 15 varieties tested in 1967 and 3-year averages for varieties tested during that period are given in the tables. Dollar value per acre has not been included in these tables because of large variations in prices received due to area of production and fiber characteristics other than staple and mike.

Fiber analyses were conducted by a commercial testing company and are given for three locations. Fiber data reported include strength which is given in thousand pounds per square inch tensile strength, upper half mean (UHM) which is the average length in inches

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of the longest half of the fiber sample tested, mean (M) which is the average length in inches of all fibers in the sample tested, and uniformity ratio (U. R.) which is an indication of fiber length uniformity obtained by dividing M by UHM and multiplying by 100. Staple length in 32nds inches and micronaire index are given for all locations.

These cotton performance data are

intended as an aid to cotton producers in the Hill Section of Mississippi in making decisions concerning which varieties to plant. For this use, the three-year averages are more reliable than any single year's results. For the newer varieties, however, only 1967 data is available and decisions concerning these varieties should be made with caution.

Summary Tables

Lint yield of 15 cotton varieties tested at 7 locations in the Hill Section in 1967.

Variety	Brooksville	Holly Springs Bottom	Newton Hill	Pontotoc Flatwoods	Raymond	State College	Ave.	
Hancock	732	688	630	1085	643	1221	654	808
Coker 201	624	693	627	1117	513	1107	782	780
MO-61-470F	517	573	535	1009	409	1300	789	733
Hybee 200	660	571	549	1089	444	1119	664	728
Deltapine 16	649	597	544	1111	417	1018	655	713
Stoneville 213	656	513	465	1065	408	1083	618	686
Coker 413-68	422	461	438	984	424	1140	695	681
McNair 1032	594	481	510	1150	427	1061	526	678
Dixie King II	741	629	647	924	448	1110	616	667
Stoneville 7A	623	497	457	990	380	976	676	657
Esco Allsmooth	726	419	446	1020	375	781	642	630
Deltapine 45A	590	485	383	1056	523	615	753	629
Deltapine 15A	645	454	493	1013	449	646	679	626
Deltapine Smoothleaf	562	496	456	853	325	912	656	609
Stoneville 508	651	404	412	834	349	894	603	592

Three-year average lint yield of 7 cotton varieties tested at 7 locations in the Hill Section in 1965-1967.

Variety	Brooksville	Holly Springs Bottom	Newton Hill	Pontotoc Flatwoods	Raymond	State College	Ave.	
Coker 201	706	797	617	1071	644	1065	887	827
Stoneville 213	745	678	602	1011	518	1084	868	784
Dixie King H	721	729	646	917	623	965	736	771
McNair 1032	686	705	556	1069	584	995	771	766
Stoneville 7A	702	649	551	898	582	922	849	736
Deltapine Smoothleaf	696	715	549	841	418	938	813	710
Deltapine 45A	661	706	495	939	502	817	808	704

Black Belt

Cotton variety performance at the Black Belt Branch Experiment Station, Brooksville, in 1967.

Variety	Yield per acre		Lint pct. %	Bolls per pound		Pct. first picking %	Fiber Properties	
	Seed Cotton Lbs.	Lint Lbs.		Seed Cotton No.	Lint No.		Staple 1/32 in.	Micro- naire Index
Dixie King II	1912	741	38.8	66	170	75	34.0	4.8
Hancock	1819	732	40.3	70	173	81	34.3	4.7
Esco Allsmooth	1918	726	37.8	69	181	76	34.3	4.7
Hybee 200	1784	660	37.0	79	214	75	34.0	4.6
Stoneville 213	1682	656	39.0	84	215	82	34.0	4.8
Stoneville 508	1774	651	36.7	82	224	73	36.0	3.7
Deltapine 16	1665	649	39.0	89	229	80	34.3	4.5
Deltapine 15A	1655	645	39.0	94	240	70	34.3	3.7
Coker 201	1541	624	40.5	81	200	76	34.3	4.6
Stoneville 7A	1585	623	39.3	78	198	80	34.0	4.9
Coker 413-68	1644	622	37.8	81	215	75	35.0	4.3
McNair 1032	1560	594	38.1	83	217	71	33.6	5.0
Deltapine 45A	1556	590	37.9	90	238	78	34.3	4.4
Deltapine Smoothleaf	1433	562	39.2	95	241	77	34.3	4.5
MO-61-470F	1369	517	37.8	72	191	82	34.3	4.5
L.S.D. @ 5%		85						
C.V.		13%						

Soil - Houston Clay; Fertilizer - 60-60-60; Planted April 17; Poisoned 23 times.

Three-year averages, Black Belt Branch Station, Brooksville

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent 1st picking	Staple Length	Mike*
	Lbs.	%	No.	%	1/32 in.	Index
Stoneville 213	745	40.2	79	70	33.6	5.0
Dixie King II	721	39.4	65	71	33.4	4.7
Coker 201	706	40.3	76	65	33.9	4.8
Stoneville 7A	702	39.8	77	66	34.0	4.9
Deltapine Smoothleaf	696	40.4	90	65	34.0	4.7
McNair 1032	686	38.8	79	67	33.0	4.8
Deltapine 45A	661	39.3	83	70	33.7	4.6
Esco Allsmooth*	576	37.2	68	76	33.6	4.6
Hybee 200*	550	38.0	78	76	33.8	4.6
Coker 413*	547	37.8	82	77	34.2	4.5

* Two-year averages, 1966 and 1967.

Brown Loam

Cotton variety performance at the Brown Loam Branch Experiment Station, Raymond in 1967

Variety	Yield per acre			Bolls per pound		Pct. first picking %	Fiber Properties	
	Seed Cotton Lbs.	Lint Lbs.	Lint pct. %	Seed Cotton No.	Lint No.		Staple 1/32 in.	Micro-naire Index
MO-61-47QF	3268	1300	39.8	63	159	74	33.3	4.9
Hancock	2745	1221	44.5	66	148	68	33.0	4.5
Coker 413-68	2687	1140	42.4	79	185	56	33.7	4.2
Hybee 200	2846	1119	39.3	74	188	62	33.3	4.3
Dixie King II	2715	1110	40.9	59	145	65	35.7	4.8
Coker 201	2712	1107	40.8	70	172	57	33.3	4.9
Stoneville 213	2728	1083	39.7	76	192	59	32.7	5.0
McNair 1032	2731	1061	38.9	78	202	52	33.0	4.7
Deltapine 16	2707	1018	37.6	81	215	54	33.7	4.7
Stoneville 7A	2498	976	39.1	84	215	56	33.0	4.6
Deltapine Smoothleaf	2269	912	40.2	89	222	48	32.7	4.3
Stoneville 508	2447	894	36.6	78	213	54	34.0	3.7
Esco Allsmooth	2117	781	35.9	66	185	60	32.7	4.2
Deltapine 15A	2153	646	30.3	94	313	57	32.3	4.1
Deltapine 45A	1598	615	38.5	93	240	32	32.0	3.9
L.S.D. @ 5%		60						
C.V.		16%						

Soil - Calloway silt loam; Fertilizer - 111-78-78; Planted May 16; Poisoned 7 times.

Three-year averages, Brown Loam Station, Raymond

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent 1st picking	Staple Length	Mike*
	Lbs.	%	No.	%	1/32 in.	Index
Coker 201	1065	40.2	73	74	33.3	5.3
Stoneville 213	1064	39.6	76	73	33.6	5.3
McNair 1032	995	38.8	82	67	32.8	5.2
Dixie King II	956	38.2	62	75	33.8	5.0
Deltapine Smoothleaf	938	39.5	83	67	33.6	5.1
Stoneville 7A	922	39.6	80	69	33.5	5.2
Deltapine 45A	817	38.4	82	62	33.1	4.8
Coker 413*	906	40.5	88	66	33.6	4.6
Hybee 200*	843	40.0	76	72	33.2	4.8
Esco Allsmooth*	776	37.6	72	68	32.8	4.6

* Two-year averages, 1966 and 1967.

Coastal Plain

Cotton variety performance at the Coastal Plain Branch Experiment Station, Newton, in 1967.

Variety	Yield per acre		Lint pct. %	Bolls per pound		pct. first picking %	Fiber properties					U. R. %
	Seed Cotton Lbs.	Lint Lbs.		Seed Cotton No.	Lint No.		Staple 1/32 in.	Micro- naire Index	Strength M.P.S.I.	UHM In.	M In.	
McNair	2729	1150	42.1	73	174	90	33.3	5.6	81	1.02	.83	84
Coker 201	2563	1117	43.6	68	156	93	34.3	5.0	79	1.12	.93	83
Deptapine 16	2612	1111	42.5	72	170	88	34.3	4.9	74	1.10	.91	81
Hybee 200	2587	1089	42.1	71	168	93	34.0	5.0	80	1.10	.90	82
Hancock	2496	1085	43.5	64	148	95	33.7	5.1	82	1.02	.83	81
Stoneville 213	2540	1065	41.9	70	167	94	34.0	5.2	78	1.09	.90	82
Deltapine 45A	2488	1058	42.5	75	176	93	34.0	5.0	76	1.08	.90	81
Esco Allsmooth	2519	1020	40.5	63	155	91	33.7	4.5	80	1.08	.88	81
Deltapine 15A	2379	1013	42.6	77	180	88	33.0	4.4	75	1.06	.85	80
MO-61-470F	2429	1009	41.5	64	154	92	34.0	5.4	80	1.08	.88	82
Stoneville 7A	2416	990	41.0	66	160	92	34.3	5.0	83	1.11	.91	82
Coker 413-68	2315	984	42.5	73	172	93	34.7	4.5	85	1.14	.94	83
Dixie King II	2182	924	42.4	55	129	92	33.3	5.1	84	1.06	.86	81
Deltapine Smoothleaf	2041	853	41.8	80	191	90	34.0	4.8	77	1.10	.91	82
Stoneville 508	2093	834	39.8	68	170	92	35.3	4.0	76	1.17	.94	81
L.S.D. @ 5%	43											
C.V.	11%											
Three-year averages, Coastal Plain Branch Station, Newton												
Variety	Lbs.	Lint per acre	Lint pct	Bolls per pounds	Percent 1st picking	Staple Length	Mike*					
								No.	%	1/32 in.	Index	
Coker 201	1071	42.7	71	79	33.8	5.1						
McNair 1032	1069	41.2	76	75	33.3	5.3						
Stoneville 213	1011	41.4	71	79	34.3	5.2						
Deltapine 45A	939	41.1	75	76	34.5	5.0						
Dixie King II	917	41.2	55	79	33.5	5.0						
Stoneville 7A	898	41.1	72	76	34.3	5.0						
Deltapine Smoothleaf	841	41.2	82	74	33.8	4.8						
Hybee 200*	1040	41.2	72	78	33.8	5.0						
Esco Allsmooth*	1018	39.9	62	78	33.4	4.6						
Coker 413*	982	41.5	72	74	34.4	4.6						

* Two-year averages, 1966 and 1967.

Soil—Prentiss loam; Fertilizer—72-72-72;
Planted April 17; Poisoned 21 times.

North Mississippi, Bottom Land

Cotton variety performance at the North Mississippi Branch Experiment Station, Holly Springs on bottom land in 1967

Variety	Yield per acre		Lint pct. %	Bolls per pound		pct. first picking %	Staple 1/32 in.	Fiber properties		UHM In.	M In.	U.R. %
	Cotton Lbs.	Seed Lbs.		Cotton No.	Lint No.			Micro- naire Index	Strength M.P.S.I.			
Coker 210	1893	693	36.5	67	185	100	35.3	3.6	77	1.14	.92	81
Hancock	1847	688	37.3	62	167	100	34.0	3.8	81	1.11	.93	84
Dixie King II	1799	629	34.9	57	164	100	34.7	3.6	79	1.10	.89	81
Deltapine 16	1659	597	36.0	70	195	100	34.3	3.6	75	1.16	.95	82
MO-61-47OF	1650	573	34.7	62	177	100	34.7	3.9	76	1.12	.91	81
Hybee 200	1664	571	34.3	66	192	100	35.0	3.9	77	1.12	.91	81
NMB	1596	565	35.4	70	198	100	34.7	3.8	77	1.15	.95	83
Stoneville 213	1530	513	33.5	68	204	100	34.3	3.7	77	1.12	.92	82
Stoneville 7A	1518	497	32.8	68	207	100	35.0	3.6	81	1.12	.89	80
Deltapine Smoothleaf	1425	496	34.8	77	221	100	35.3	3.8	71	1.12	.92	81
Deltapine 45A	1406	485	34.5	71	204	100	35.0	3.5	76	1.18	.98	84
McNair 1032	1352	481	35.6	72	202	100	34.0	4.0	77	1.08	.89	83
Coker 413-68	1286	461	35.9	77	213	100	35.7	3.5	83	1.16	.93	80
Deltapine 15A	1251	454	36.3	82	225	100	35.0	3.3	75	1.08	.85	79
Esco Allsmooth	1288	419	32.5	60	184	100	34.7	3.4	75	1.11	.90	81
Stoneville 508	1240	404	32.5	71	219	100	36.0	3.0	75	1.17	.96	82

Three-year averages, bottom land, North Mississippi Branch Station, Holly Springs

Variety	Lint per acre		Lint pct. %	Bolls per pound		Percent 1st picking %	Staple Length 1/32 in.	Mike*
	Lbs.	No.		No.	%			
Coker 201	797	69	39.7	69	-	34.7	4.0	
Dixie King II	729	59	38.0	59	-	34.0	4.5	
Deltapine Smoothleaf	715	75	38.3	75	-	34.2	4.3	
Deltapine 45A	706	74	38.4	74	-	34.1	3.8	
McNair 1032	705	73	38.1	73	-	33.9	4.4	
Stoneville 213	678	72	37.6	72	-	33.7	4.2	
Stoneville 7A	649	72	37.2	72	-	34.6	4.2	
Hybee 200*	652	68	35.9	68	-	35.0	4.4	
Esco Allsmooth*	587	62	34.6	62	-	34.4	4.2	
Coker 413*	582	80	36.5	80	-	35.4	4.1	

* Two-year averages, 1966 and 1967.

Soil - Collins silt loam; Fertilizer - 72-48-48;

Planted May 5; Poisoned 22 times.

L.S.D. @ 5%
C.V. 17%

North Mississippi Hill Land

Cotton variety performance at the North Mississippi Branch Experiment Station,
Holly Springs, on hill land in 1967.

Variety	Yield per acre			Bolls per pound			Fiber Properties	
	Seed Cotton Lbs.	Lint Lbs.	Lint pct. %	Seed Cotton No.	Lint No.	Pct. first picking %	Staple 1/32 in.	Micro- naire Index
Dixie King II	1594	647	40.6	66	162	100	34.0	4.1
Hancock	1487	630	42.3	77	182	100	34.0	3.8
Coker 201	1473	627	42.6	82	192	100	34.7	3.7
Hybee 200	1400	549	39.2	76	194	100	34.0	3.7
Deltapine 16	1342	544	40.5	84	207	100	33.7	3.7
MO-61-47OF	1396	535	38.3	70	183	100	34.3	3.8
NMB	1322	528	40.0	80	201	100	34.3	3.7
McNair 1032	1291	510	39.5	83	211	100	33.3	3.8
Deltapine 15 A	1162	493	42.4	101	237	100	33.7	3.1
Stoneville 213	1201	465	38.7	85	220	100	34.3	3.5
Stoneville 7A	1202	457	38.1	86	226	100	34.3	3.8
Deltapine Smoothleaf	1155	456	39.5	97	247	100	34.7	3.5
Esco Allsmooth	1144	446	39.0	67	172	100	34.0	3.7
Coker 413-68	1101	438	39.8	85	213	100	35.0	3.4
Stoneville 508	1103	412	37.3	84	226	100	35.3	3.2
Deltapine 45A	968	383	39.6	82	208	100	34.3	3.4
L.S.D. @ 5%		75						
C.V.		13%						

Soil - Grenada silt loam; Fertilizer - 72-48-48; Planted May 4; Poisoned 22 times.

Three-year averages, hill land, North Mississippi Branch Station, Holly Springs

Variety	Lint per acre	Lint pct.	Bolls per pounds	Percent 1st picking	Staple Length	Mike*
	Lbs.	%	No.	%	1/32 in.	Index
Dixie King II	646	41.2	70	-	33.0	4.8
Coker 201	617	42.7	85	-	33.2	4.7
Stoneville 213	602	40.7	82	-	33.5	4.7
McNair 1032	556	40.6	89	-	32.8	4.4
Stoneville 7A	551	40.8	87	-	33.5	4.8
Deltapine Smoothleaf	549	41.2	93	-	33.4	4.6
Deltapine 45A	495	41.2	87	-	32.7	4.7
Hybee 200*	584	40.4	80	-	33.5	4.7
Esco Allsmooth*	484	40.3	71	-	33.2	4.6
Coker 413*	457	40.6	88	-	34.0	4.4

* Two-year averages, 1966 and 1967.

Northeast Mississippi

Three-year averages, Northeast Mississippi Branch Station, Verona*

Variety	Lint per acre	Lint pct.	Bolls per pounds	Percent 1st picking	Staple Length
	Lbs.	%	No.	%	1/32 in.
Dixie King II	853	38.7	57	-	33.9
Stoneville 213	834	38.3	73	-	34.2
Carolina Queen	823	39.1	72	-	34.7
Pennington Hybee	816	38.0	64	-	34.3
Deltapine Smoothleaf	808	40.2	76	-	34.5
Auburn 56	762	37.1	69	-	34.2
Stoneville 7A	762	38.3	74	-	34.7
Empire WR 61	741	36.3	59	-	34.4
Rex Smoothleaf	726	36.4	63	-	34.1
Auburn M	667	37.8	66	-	34.4

* The three-years averaged are 1964-66 because of test failure in 1967.

Pontotoc, Ridge

Three-year averages, Pontotoc Ridge, Pontotoc Branch Station, Pontotoc*

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent 1st picking	Staple Length
	Lbs.	%	No.	%	1/32 in.
Rex Smoothleaf	958	38.9	67	-	33.3
Dixie King II	937	39.7	64	-	33.4
Empire WR 61	881	39.5	60	-	32.9
Auburn M	876	38.4	72	-	32.8
Carolina Queen	870	39.7	78	-	33.5
Stoneville 7A	881	39.8	76	-	33.4
Stoneville 213	859	40.1	78	-	33.0
Auburn 56	834	37.9	74	-	33.0
Pennington Hybee	844	39.0	71	-	33.1
Deltapine Smoothleaf	711	40.1	83	-	33.2

* The three years averaged are 1964-1966 because of test failure in 1967.

Pontotoc, Flatwoods

Cotton variety performance at Pontotoc Branch Experiment Station, Pontotoc,
on flatwoods soil in 1967.

Variety	Yield per acre		Lint pct. %	Bolls per pound		Pct. first picking %	Fiber Properties	
	Seed Cotton Lbs.	Lint Lbs.		Seed Cotton No.	Lint No.		Staple 1/32 in.	Micro- naire Index
Hancock	1644	643	39.1	58	147	100	34	3.9
Deltapine 45A	1414	523	37.0	72	193	100	35	3.6
Coker 201	1385	513	37.0	66	179	100	35	3.6
Deltapine 15A	1172	449	38.3	73	190	100	34	3.5
Dixie King II	1229	448	36.5	58	158	100	34	3.4
Hybee 200	1257	444	35.3	64	180	100	35	3.7
McNair 1032	1156	427	36.9	66	180	100	34	4.0
Coker 413-68	1160	424	36.5	70	192	100	36	3.4
Deltapine 16	1160	417	36.0	64	179	100	36	3.8
MO-61-47OF	1168	409	35.0	60	173	100	35	4.0
Stoneville 213	1181	408	34.6	67	195	100	35	3.8
Stoneville 7A	1107	380	34.3	66	193	100	36	3.8
Esco Allsmooth	1111	375	33.7	60	179	199	35	3.1
Stoneville 508	1026	349	34.0	69	203	100	36	3.0
Deltapine Smoothleaf	1000	325	32.5	67	205	100	36	3.0
L.S.D. @ 5%		82						
C.V.		18%						

Soil - Bude; Fertilizer - 80-60-60 plus boron; Planted May 10; Poisoned 14 times.

Three-year averages, flatwoods, Pontotoc Branch Station, Pontotoc

Variety	Lint per acre	Lint pct.	Bolls per pounds	Percent 1st picking	Staple Length	Mike*
	Lbs.	%	No.	%	1/32 in.	Index
Coker 201	644	39.0	68	-	34.0	4.4
Dixie King II	623	37.5	60	-	34.0	4.0
McNair 1032	584	38.4	72	-	33.7	4.6
Stoneville 7A	582	37.4	70	-	35.0	4.4
Stoneville 213	518	37.1	76	-	34.3	4.4
Deltapine 45A	502	37.9	73	-	34.0	4.4
Deltapine Smoothleaf	418	36.5	72	-	34.9	4.0
Esco Allsmooth*	608	36.6	64	-	34.0	4.0
Hybee 200*	524	36.9	70	-	34.0	4.4
Coker 413*	470	36.9	76	-	35.0	4.0

* Two-year averages, 1966 and 1967.

State College

Cotton variety performance at the Central Station, State College, in 1967.

Variety	Yield per acre		Lint %	Bolls per pound		pct. first picking %	Fiber properties				U.R. %	
	Seed Cotton Lbs.	Lint Lbs.		Seed Cotton No.	Lint No.		Staple 1/32 in.	Micro- Index	Strength M.P.S.I.	UHM In.		
MO-61-470F	1967	789	40.1	64	159	77	34.0	4.4	85	1.12	.94	84
Coker 201	1956	782	40.0	70	176	75	34.7	4.1	82	1.13	.95	84
Deltapine 45A	1986	753	37.9	72	189	64	34.7	4.3	80	1.09	.89	82
Coker 413-68	1857	695	37.4	72	192	69	35.3	3.8	89	1.19	.97	82
Deltapine 15A	1702	679	39.9	86	216	69	34.3	3.7	73	1.07	.88	82
Stoneville 7A	1817	676	37.2	71	191	63	34.7	4.5	86	1.12	.92	82
Hybee 200	1778	664	37.3	67	179	62	34.7	4.4	78	1.11	.89	.80
Deltapine Smoothleaf	1727	656	38.0	85	225	70	34.0	4.1	77	1.12	.89	79
Deltapine 16	1703	655	38.5	76	199	66	35.0	4.1	80	1.11	.89	80
Hancock	1645	654	39.7	63	160	85	34.3	4.0	85	1.06	.85	80
Esco Allsmooth	1782	642	36.0	64	177	74	34.0	3.7	82	1.08	.87	81
Stoneville 213	1922	618	32.2	72	224	67	34.3	4.7	78	1.10	.92	84
Dixie King II	1641	616	37.5	57	152	58	34.3	4.1	82	1.10	.91	83
Stoneville 508	1671	603	36.1	75	208	59	35.3	4.5	79	1.16	.92	79
McNair 1032	1404	526	37.5	78	208	51	33.7	4.4	84	1.07	.88	82
Three-year averages, Central Station, State College												
L.S.D. @ 5%		97										
C.V.		13%										

Three-year averages, Central Station, State College

Variety	Lint per acre		Lint pct.	Bolls per pound		Percent 1st picking		Staple Length		Mike*	
	Lbs.			No.		%		1/32 in.		Index	
Coker 201	887		39.8	66		80		34.5		4.6	
Stoneville 213	868		37.0	70		76		34.3		4.9	
Stoneville 7A	849		38.3	69		73		34.6		4.9	
Deltapine Smoothleaf	813		39.2	80		75		34.1		4.5	
Deltapine 45A	808		38.6	72		73		34.2		4.8	
Dixie King II	796		38.3	57		76		34.0		4.5	
McNair 1032	771		37.9	74		67		33.7		4.8	
Hybee 200*	790		38.1	68		74		34.4		4.8	
Esco Allsmooth*	786		36.7	63		82		33.8		4.1	
Coker 413*	768		38.1	74		77		34.9		4.2	

* Two-year averages, 1966 and 1967.

Soil - Verona fine sandy loam; Fertilizer - 52-52-52; Planted May 10; Poisoned - not available.



Wintering Beef Cows In South Mississippi

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On The Cover:

Pastures normally provide ample forage for beef cattle in summer but wintering is considerably more expensive. This study compares winter methods in South Mississippi.

WINTERING BEEF COWS IN SOUTH MISSISSIPPI

WILLIAM A. BROCK, W. W. KILBY and C. L. BLOUNT¹

The 120-day period from December 1 to April 1 is the most critical and expensive season for the cattle industry. Much of the expense in a cow-calf program is supplying roughage and concentrates for wintering the brood herd.

Under poor management it is not unusual for a cow to lose 20 percent or more of her body weight during this period. This is when most death losses occur because a cow in poor physical condition is more susceptible to parasites and diseases. Generally this is the period when most calves are dropped. A cow in poor physical condition may not be able to give her calf as good a start in life and this may result in a smaller, lower quality calf at weaning time.

Finishing yearling calves on winter grazing has been very successful at the South Mississippi Branch Station. A review of the results for eleven years prior to the beginning of this study showed that calves had made economical gains on winter grazing, and that winter grazing was dependable throughout the winter in South Mississippi. Also one herd of cows had been wintered for 11 cents per cow per day on limited winter grazing, while it costs 26 cents per cow per day to winter another herd on hay and one pound of cotton seed meal per day not including labor for feeding.

It was decided in the fall of 1959 to initiate a more detailed study of various methods of wintering brood cows. The objectives of the test were to determine

(1) the cost of various methods, (2) the effects of various methods on the weight change of cows and on the average daily gain of calves, and (3) the amount of feed consumed by the cows.

Mature Hereford cows from two herds of the South Mississippi Branch Experiment Station were used in this experiment. The cows were allotted on the basis of weight and age to each treatment. The average weight of the cows was approximately 1050 pounds at the beginning of each of the winter periods. One herd of cattle is maintained at the McNeill Unit and another at the Tung Unit of the South Mississippi Station. All cows were kept on similar pastures when they were not on the test. Labor costs of \$.75 per hour, and \$3.00 per hour for man and tractor were used in determining the labor cost. Labor costs were figured on the basis of time required to feed or move a group of 25 cows.

McNeill Unit 1959-60 through 1963-64

The winter pasture treatment consisted of a mixture of oats and ryegrass and was planted on approximately October 1 each year. The pastures were fertilized with 100-80-60 at planting and and topdressed with 66 pounds of nitrogen in January. The pasture area was limed with one ton of lime per acre every two years. Oats were planted at the rate of four bushels per acre and ryegrass at the rate of 15 pounds per acre. The average cost per acre of the winter grazing, including land preparation, was \$31.60 per year. The bottom strand of wire on the fence between the grazing

¹Agronomist, Horticulturist, and former Agronomist, respectively, South Mississippi Branch Experiment Station, Poplarville, Mississippi. Mr. Blount resigned September, 1964.

area and the holding area was removed to allow the calves to creep graze on the winter grazing while the cows were in the holding area. Salt, minerals and water were available free choice in the holding area. The holding area consisted of approximately 870 square feet per cow-calf unit.

A sorghum-sudan hybrid was planted during June of each year following the winter grazing, and was harvested in September. The silage was stored in a concreted trench silo and fed with a front and fork in open troughs. The average dry matter content of the silage was 28.1 percent at time of feeding. Two pounds of cottonseed meal per cow was fed daily along with the silage. The silage cost \$6.00 per ton to produce and store, and the meal cost \$89.25 per ton. These prices were used in calculating the cost of the silage treatment.

Mixed grass hay harvested on the Experiment Station was used in the test. It was fed free choice in a hay rack. Cottonseed meal was fed daily in an open trough at the rate of two pounds per head per day. The hay cost \$20.00 per ton to produce and store, and the meal \$89.25 per ton. These prices were used in calculating the daily cost of the hay treatment.

The weight record period of the test was started approximately December 1 and concluded approximately March 1 each year for all treatments. The stocking per acre was maintained at a constant rate for the entire winter grazing season on the pasture treatment, and the total grazing period (approximately December 1 to April 15) was used in figuring the cost per day of winter grazing. Cows were allowed only three hours of grazing per day. They calved during December and January while on test.

Results from this phase of the experiment are shown in Tables 1 and 2. The oat-ryegrass grazing treatment, which was predominantly oats during the fall and winter, was damaged by cold during two of the five years of the test and was not ready for grazing on December 1 on another year. The per day cost on the grazing treatment includes the cost of hay and meal fed during the per-

Daily cost of all treatments were approximately the same. It should be noted that the cost of the oat-ryegrass grazing treatment varied from year to year due to the cold damage to the oats, (Table 1). The cost of the hay-cottonseed meal treatment and silage and meal treatment was relatively constant over the five years of the study.

Tung Unit 1959-60 through 1962-63

The ryegrass pasture treatment was planted approximately September 10 of each year and fertilized with 82-60-45 at planting. The pasture was not topdressed. Weight records from this phase of the experiment were taken from the period approximately December 1 to March 10. The cows grazed three hours per day on the ryegrass until April 15, and the cost per day was calculated for the entire winter grazing season. Ryegrass was planted at the rate of 40 pounds per acre. The pasture cost, including land preparation, averaged \$24.16 per acre per year. The calves were allowed to creep graze on the winter grazing while the cows were in the holding area by removing the bottom strand of wire between the pasture and the holding area. Salt, minerals and water were available free choice in the holding area which consisted of approximately one-half acre per cow-calf unit.

Table 1. Annual performance at the McNeill Unit

	Weight loss/ cow in lbs.	Amount feed/cow per day ¹	Daily gain of calf	Cost per day (cents)
1959-60				
Hay-C.S.M.	68	19.9	.93	29.5
Silage-C.S.M.	94	57.5	1.00	34.5
Oats-ryegrass grazing	134	3 hr.	1.09	18.6
1960-61				
Hay-C.S.M.	144	21.8	1.06	31.1
Silage-C.S.M.	160	37.0	1.08	34.3
Oats-ryegrass grazing	132	3 hr.	1.63	19.9
1961-62				
Hay-C.S.M.	73	22.6	1.20	30.8
Silage-C.S.M.	156	46.0	.99	30.2
Oats-ryegrass grazing	157	3 hr.	1.40	32.9 ²
1962-63				
Hay-C.S.M.	26	33.0	1.50	43.1
Silage-C.S.M.	83	77.0	1.27	36.5
Oats-ryegrass grazing	66	3 hr.	1.39	31.5 ²
1963-64				
Hay-C.S.M.	85	24.0	1.40	42.7
Silage-C.S.M.	38	80.0	1.46	36.7
Oats-ryegrass grazing	66	3 hr.	1.53	40.1 ³

¹ Cottonseed meal was fed at the rate of 2 lbs. per head each day each year. The number represents pounds of hay or silage.

² Hay was fed as a result of cold damage to the oats.

³ Hay and cottonseed meal was fed for 13 days until grazing was available.

Table 2. Five-year average performance at the McNeill Unit 1959-60 through 1963-64.

	Hay & C.S.M.	Sorghum Silage & C.S.M.	Oat-ryegrass Grazing
No. of cows	12.4	15.2	12.4
Days on test	80.8	80.8	80.8
Av. weight loss/cow in lbs.	79.2	106.2	109.8
Av. amount feed/cow/day in lbs.	24.3 Hay 2 CSM	59.5 Silage 2 CSM	3 hrs./day
Acres/cow and calf			.75
Av. daily gain of calf	1.22	1.16	1.41
Av. cost (feed & labor/cow/day, cents)	35.4	34.4	28.6 ¹

¹ The oats were damaged by cold during two of the five years and the cost reflects the additional hay and cottonseed meal fed.

Hay used in this phase of the experiment was mixed grass and Alyce clover harvested at the Tung Unit. The hay cost \$20.00 per ton to produce and store, and the meal cost \$89.25 per ton. These prices were used in calculating the daily cost of the hay-cotton seed meal treat-

ment.

All cows calved during December and January while on test. Hay was fed free choice in a hay rack.

Results from this phase of the experiment are shown in Tables 3 and 4.

Table 3. Annual performance at the tung unit

	Weight loss/ cow in lbs.	Amount feed/cow per day ¹	Daily gain of calf	Cost per day (cents)
1959-60				
Hay-C.S.M.	1	22.5	.77	31.1
Ryegrass Grazing	+72	3 hr.	1.92	18.7
1960-61				
Hay-C.S.M.	83	22.0	1.97	30.4
Ryegrass Grazing	34	3 hr.	2.31	14.8
1961-62				
Hay-C.S.M.	41	22.0	1.95	30.2
Ryegrass Grazing	57	3 hr.	1.83	17.2
1962-63				
Hay-C.S.M.	121	24.0	1.84	34.5
Ryegrass Grazing	26	3 hr.	2.35	13.7

¹ Cottonseed meal was fed at the rate of two pounds per head per day each year. The number represents pounds of hay.

Table 4. Four-Year Average Performance at the Tung Unit 1959-60 Through 1962-63.

	Hay & C.S.M.	Limited Ryegrass Grazing
No. of cows	8.0	8.3
Days on test	90.5	90.5
Av. weight loss/cow in lbs.	61.5	11.2
Av. amount feed/cow/day in lbs.	24.6 Hay 2 CSM	3 hrs./day
Acres/cow and calf		.70
Av. daily gain of calf	1.63	2.10
Av. cost (feed & labor /cow/day, Cents)	31.6	16.1

Table 5. Performance at the McNeill Unit 1965-66

	Hay & C.S.M.	Sorghum silage & C.S.M.	Limited ryegrass grazing
No. of cows	12	12	12
Days on test	126	126	126
Av. weight loss/cow in lbs.	130.0	147.0	85.0
Av. amount feed/cow/day in lbs.	23.2 Hay 1.1 CSM ¹	68.0 Silage 1.0 CSM ¹	3 hrs./day
Acres/cow and calf			.75
Av. daily gain of calf	1.24	1.15	2.24
Av. cost (feed & labor/cow/day, cents)	34.6	33.3	16.2

¹ Fed-two parts of cotton seed meal to one part salt.

McNeill 1955-66

The test was begun on December 1 and continued until the end of the winter grazing season. All cows calved while on test. Weight records were calculated for the entire 126 days of the study.

Ryegrass was planted on September 10 and fertilized with 100-60-60 at planting time and was not topdressed. The stocking rate was maintained at a constant rate of .75 acres per cow. The cows were allowed only three hours of grazing per day. The average per acre cost of the winter grazing, including land preparation, was \$27.40.

A sorghum-sudan hybrid was planted on June 5 following winter grazing, and harvested at the head stage of maturity and stored in a concreted trench silo. It was fed in open troughs with a tractor front end loader. Cottonseed meal was fed in a salt mix containing two parts of cottonseed meal and one part of white salt. The silage cost \$6.00 per ton to produce and store, and the meal \$89.00 per ton. These prices were used in calculating the daily feed cost.

Grass hay harvested on the McNeill Unit of the Experiment Station was fed in a hay rack. A cottonseed meal and salt mixture consisting of two parts meal and one part salt was fed free choice. The hay cost \$20.00 per ton to produce and store, and the meal \$89.00 per ton. Results of the test are shown in Table 5.

McNeill 1966-67

The test was begun on December 1 and continued until the end of the winter grazing season. All cows calved while on the test. Weight records were calculated for the entire 120 days of the study. Ryegrass was planted on September 12 and fertilized with 100-60-60 at planting time and was not topdressed. The stocking rate was maintained at a constant .70 acres per cow.

Corn silage containing 41.13 percent dry matter was fed at the rate of 50 pounds per head per day. The silage had 10 pounds of urea added per ton at the time of ensiling. No other source of protein was fed. The protein content of the silage was 12.32 percent on a dry basis. A cost of \$8.50 to produce and store was used in calculating the cost of the corn silage.

Mixed grass hay harvested at the McNeill Unit was fed free choice in a hay rack. The protein content of the hay was 8.72 percent. Pro-Lix, fed free choice with a commercial "lick wheel" type feeder, was placed 200 yards from the hay and water source. The hay cost \$20.00 per ton to produce and store and the Pro-Lix \$89.00 per ton. The results of the test are shown in Table 6.

Discussion

During the years 1959-60 through 1963-64, the ryegrass treatment at the Tung Unit proved to be the most economical and satisfactory method of wintering brood cows in South Mississippi. The oat-ryegrass mixture pasture at McNeill produced satisfactory and economical gains during the years that the oats were not damaged by cold. As a result of the cold damage the oat-ryegrass mixture was replaced by ryegrass at McNeill during the 1965-66 and the 1966-67 growing season, and results were very similar to those obtained previously at the Tung Station.

The sorghum silage used throughout this test was a sorghum-sudan hybrid type, harvested at the head stage of maturity. These sorghum-sudan silages were not as satisfactory as the limited grazing treatment. Recent research has shown the sorghum-sudan hybrids harvested at this stage of maturity are a poor quality silage. The sorghum-sudan hybrids have been replaced during 1967-

Table 6. Performance at the McNeill Unit 1966-67

	Pro-Lix Hay	Limited Corn Silage with urea ¹	Limited Ryegrass Grazing
No. of cows on test	15	15	15
Days on test	120	120	120
Av. weight loss/cow in lbs.	-24	-45	+16
Av. amount feed/cow/day in lbs.	2.0 Pro-Lix 25.1 Hay	50.0	
Acres/cow and calf			.70
Av. daily gain of calf	1.06	1.13	1.63
Av. cost (feed & labor/cow/day, cents)	34.0	22.2	16.0

¹ Urea was added to corn silage at time of ensiling at the rate of 10 pounds per ton.

68 wintering period with an intermediate sorghum harvested at the hard dough stage of maturity.

Grass hay and protein performed as well as the sorghum-sudan silage and protein, but did not perform as well as limited winter grazing.

Limited corn silage fed during 1966-67 performed as well as the hay or sorghum-sudan silage fed during previous years, but it was decided that corn silage produced in South Mississippi could probably be used to greater advantages, such as feeding steers, and that the improved intermediate sorghums could be planted following winter grazing and would be a more desirable land use system.

Throughout this study the average daily gains of the suckling calves on the winter grazing were much greater than of similar calves on the hay and protein or sorghum-sudan silage and protein treatments. This greater gain made during the winter months was maintained throughout the summer while on summer pastures. The grazed calves were larger, and apparently had better developed stomachs as a result of the winter grazing as compared to calves wintered on sorghum silage or hay.

The average weight loss of the cows was less during all phases of the experiment on the limited ryegrass winter grazing treatments.

Summary and Conclusion

Grazing brood cows for three hours per day on ryegrass proved to be a more satisfactory and economical way to winter brood cows with calves than grass hay and protein or sorghum-sudan silage and protein in a seven-year study at the South Mississippi Branch Station. Results are summarized as follows:

1. Average daily cost to winter a cow-calf unit was: Limited ryegrass grazing, 16.1 cents; sorghum-sudan silage and protein, 34.2 cents; and grass hay and protein, 33.8 cents.

2. Average daily gain of the calves was: limited ryegrass grazing, 2.0 lbs.; sorghum-sudan silage and protein, 1.22 pounds; and grass hay and protein, 1.35 pounds.

3. Brood cows had an average weight loss for the wintering period of: limited ryegrass grazing, 19.0 pounds; sorghum-sudan silage and protein, 113.0 pounds; and grass hay and protein, 72.3 pounds.

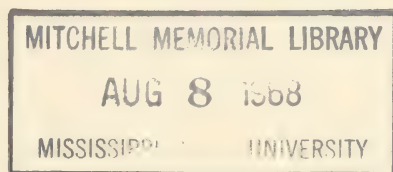
4. Limited corn silage, with urea added at time of ensiling, performed similar to sorghum-sudan silage and protein during the one year the corn silage was tested.

5. Limited oat-ryegrass grazing was satisfactory during years that oats were not damaged by cold.

Mississippi's Older Citizens

By

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SUMMARY

In recent years there has been a growing concern about the problems of the aged population. For communities to be prepared to meet the challenge they must be informed on population trends. This study analyzes such trends from 1950 to 1960 for Mississippi, its counties, and smaller areas, compiled from Census data. Where trends over a longer time span are elucidative, they are also included.

The State has gained steadily in number and proportion of older citizens. In 1950 the number was 152,964, or 7.0 per cent of the total population, while in 1960 the figure had increased to 187,543, or 8.6 per cent of the total population. In 1965 the estimated aged population of the State was 200,685 and is projected to increase more than 10 per cent by 1970, and 35 to 50 per cent by 1985.

From 1950 to 1960, the most striking increases were found in rural nonfarm areas, followed by urban areas. Rural farm areas experienced losses in number of senior citizens. Despite this numerical decline, however, there still was a gain of older citizens percentage-wise, due to the fact that the other age categories in these areas had also decreased. In rural nonfarm areas, on the other hand, changes were not consistent. In this category, changes ranged from an increase of 242 per cent in Jefferson Davis County to a decrease of 67 per cent in Hinds County. Urban places generally registered gains in aged population. These gains were most pronounced in places which in 1950 had a population of 10,000 or more. Among those, the city of Jackson gained the largest number of older citizens. In fact, the increase in Jackson, from

1950 to 1960, was greater in the aged category than for those below 65 years of age. This proportionately greater increase was observed not only in Jackson, but in all other places in the State which had populations of 10,000 or more in 1950.

On the whole, aged females not only outnumbered aged males, but there was also a continued tendency of the former to increase disproportionately. Only in rural farm areas was a high sex ratio found, that is, there was a greater number of males than females.

Inquiry into the marital status of the aged population of the State in 1960 indicated that approximately 40 per cent were widowed. Widows outnumbered widowers by about 40,000. Males were more likely to have been married more than once than were females. The proportion of aged persons who were widowed was considerably larger for the nonwhite population than for the white population. A larger proportion of urban and rural nonfarm aged persons were divorced than were older citizens classified as rural farm. The rural nonfarm category showed the greatest proportion of increase in aged divorced persons during the decade 1950-1960.

More than two-thirds of the State's aged population resided in owner-occupied dwellings.

With respect to employment, a downward trend was observed for the aged male and the reverse for the aged female.

Approximately three-fourths had an income of less than \$1,500 per year; many had to depend on other sources for support.

MISSISSIPPI'S OLDER CITIZENS

By

ELISABETH J. STOJANOVIC¹

The aged population² of the United States is increasing steadily in number and proportion and so is the public's awareness of this fact. While three decades ago the aged represented only 5.4 per cent of the total population, the 1960 Census reported that more than 16 million people in this country were 65 years of age or older, comprising approximately 9 per cent of the total population. The Census also revealed another interesting fact; namely, that during the ten-year period, 1950 to 1960, the percentage increase of the aged population in the United States was 0.9 per cent, while in Mississippi it was 1.6 per cent. Even though Mississippi's proportion of aged citizens has been consistently lower than that of the nation as a whole, it is gradually approaching the national level and, if present trends continue may exceed the national average within the next few years. This implies a need of planning for problems created by such changes.

The most common variables employed in the demography of aging are: age, sex, race, marital and family status, living arrangements, income, labor force status and occupation, and education. All these are significant in determining the needs of the aged population.

It is the purpose of this publication to revise an earlier bulletin³, and to consolidate demographic information on the aged population of Mississippi as furnished by the 1960 Census of Population and to establish trends, based on previous censuses.

Mississippi's Aged in Relation to the United States and Other Southern States

While Mississippi's aged population is proportionately slightly smaller than that of the country as a whole, in rela-

tion to other southern states she rates fifth from the top. Table 1 shows that only four of the southern states, namely Arkansas, Florida, Kentucky, and Oklahoma, have a greater proportion of aged citizens than Mississippi, a fact which was also observed in the 1950 Census. When considering the rate of increase however, Mississippi exceeds Kentucky.

Race, Residence, and Sex

In order to observe the changes that have occurred in the State's aged population, with respect to race, residence, and sex, pertinent data are presented in Tables 2, 3, and 4.

It is evident that since 1940, the State's white and nonwhite aged populations have steadily increased. Both numerically and percentagewise, however, the increase was smaller for the nonwhite than for the white population. From 1950 to 1960 the white aged population increased by 30.9 per cent, while the increase of the nonwhite population in the aged category was 11.6 per cent.

The figures tabulated above become even more meaningful when compared with the growth trend of the other segment of the population, i.e. those below 65 years of age. Here a decrease was recorded as illustrated in Table 5.

The decline in number of people below the age of 65 can be attributed to the slightly descending trend of the nonwhite population in that age category. For the white population, the upward trend in the aged population from 1950 to 1960 was expected since the total white population of the State had also shown gains. The total nonwhite population of the State, however, showed a loss, which makes the increase of aged persons in that category even more conspicuous.

¹The author acknowledges the helpful suggestions given by Dr. Marion T. Loftin, Professor of Sociology and Anthropology. She also expresses her appreciation to Mrs. Ellen S. Bryant, Assistant Sociologist, for providing the unpublished population estimates.

²Throughout this paper "aged population" refers to the age category 65 years old and over. The term will be used interchangeably with "senior citizens" and "older citizens."

³Marion T. Loftin, **Mississippi's Older People**. State College, Mississippi AES Bulletin, 599 (June, 1960).

Table 1. Percent of the Population 65 Years Old and Over for the Southern States and the U. S., 1930, 1940, 1950, 1960.

State	1930	1940	1950	1960
United States	5.4	6.8	8.1	9.0
Mississippi	3.6	5.3	7.0	8.6
Alabama	3.8	3.8	6.5	7.9
Arkansas	4.1	5.5	7.8	10.6
Florida	4.9	6.9	8.6	11.0
Georgia	4.1	5.1	6.4	7.3
Kentucky	5.5	6.6	8.0	9.4
Louisiana	3.6	5.0	6.6	7.3
North Carolina	3.8	4.5	5.5	6.6
Oklahoma	4.1	6.1	8.7	10.5
South Carolina	3.4	4.2	5.4	6.2
Tennessee	4.7	5.9	7.1	8.4
Texas	4.1	5.4	6.7	7.6
Virginia	4.8	5.8	6.5	7.1

Sources: Halbert L. Dunn, **Health and Demography**, U. S. Department of Health, Education, and Welfare, National Office of Vital Statistics, October 1956, p. 53; and Bureau of the Census, **U. S. Census of Population, 1960, General Population Characteristics**, PC (1) 26D; Table 96.

Table 2. Number of Persons 65 Years Old and Over by Race, Residence, and Sex, Mississippi, 1940, 1950, 1960.

Residence and Race	Males			Females			Total		
	1940	1950	1960	1940	1950	1960	1940	1950	1960
Total Population:									
White	30,818	41,797	51,925	30,369	45,118	61,883	61,187	86,915	113,808
Nonwhite	28,311	33,087	35,382	25,920	32,962	38,353	54,231	66,049	73,735
Total	59,129	74,884	87,307	56,289	78,080	100,236	115,418	152,964	187,543
Rural Farm:									
White	18,330	19,851	13,332	15,274	17,417	12,603	33,604	37,268	25,935
Nonwhite	20,437	19,476	10,468	16,263	16,022	8,931	36,700	35,498	19,399
Total	38,767	39,327	23,800	31,537	33,439	21,534	70,304	72,766	45,334
Rural Nonfarm:									
White	6,268	11,333	21,668	6,867	12,975	24,363	13,135	24,308	46,031
Nonwhite	3,789	6,803	14,306	4,367	8,076	15,758	8,156	14,879	30,064
Total	10,057	18,136	35,974	11,234	21,051	40,121	21,291	39,187	76,095
Urban:									
White	6,220	10,613	16,925	8,222	14,726	24,917	14,448	25,339	41,842
Nonwhite	4,085	6,808	10,608	5,290	8,864	13,664	9,375	15,672	24,272
Total	10,305	17,421	27,533	13,518	23,590	38,581	23,823	41,011	66,114

Sources: Bureau of the Census, **U. S. Census of Population, 1960, General Social Economic Characteristics**, PC (1) 26C Mississippi Table 37 (Note: figures for 1960 differ from those given in PC (1) 26B), and **U. S. Census of Population, 1950, Vol. II, Part 24, Table 53**.

Table 3. Percentage Change of Persons 65 Years Old and Over by Race, Residence, and Sex, Mississippi, 1950-1960.*

Residence and Race	Males		Females		Total	
	1950-1960		1950-1960		1950-1960	
	Change	%	Change	%	Change	%
Total Population:						
White	10,128	24.2	16,765	37.2	26,893	30.9
Nonwhite	2,295	6.9	5,391	16.4	7,686	11.6
Total	12,423	16.6	22,156	28.4	34,579	22.6
Rural Farm:						
White	-6,519	-32.8	-4,814	-27.6	-11,333	-30.4
Nonwhite	-9,008	-46.3	-7,091	-44.3	-16,099	-45.4
Total	-15,527	-39.5	-11,905	-35.6	-27,432	-37.7
Rural Nonfarm:						
White	10,335	91.2	11,388	87.8	21,723	89.4
Nonwhite	7,503	110.3	7,682	95.1	15,185	102.1
Total	17,838	98.4	19,070	90.6	36,908	94.2
Urban:						
White	6,312	59.5	10,191	69.2	16,503	65.1
Nonwhite	3,800	55.8	4,800	54.2	8,600	54.9
Total	10,112	58.2	14,991	63.5	25,103	61.2

*Figures computed from Table 2.

Table 4. Percent of the Population 65 Years Old and Over by Race, Residence, and Sex, Mississippi, 1940, 1950, 1960.

Residence and Race	Male			Female			Total		
	1940	1950	1960	1940	1950	1960	1940	1950	1960
Total Population:									
White	5.5	7.0	8.3	5.5	7.6	9.8	5.5	7.3	9.1
Nonwhite	5.4	6.9	8.0	4.7	6.5	8.0	5.0	6.7	8.0
Total	5.5	6.9	8.2	5.1	7.1	9.0	5.3	7.0	8.6
Rural Farm:									
White	5.7	7.7	10.7	5.1	7.2	10.6	5.4	7.5	10.6
Nonwhite	5.2	6.6	7.0	4.2	5.4	6.0	4.7	6.0	6.5
Total	5.4	7.1	8.7	4.6	6.2	8.0	5.0	6.6	8.4
Rural Nonfarm:									
White	5.6	7.3	8.9	5.9	8.2	10.0	5.8	7.8	9.4
Nonwhite	6.5	8.8	9.1	6.7	9.5	9.3	6.6	9.2	9.2
Total	5.9	7.8	9.0	6.2	8.7	9.7	6.1	8.3	9.3
Urban:									
White	5.1	5.8	6.6	6.2	7.8	9.3	5.7	6.8	8.0
Nonwhite	5.1	6.4	7.8	5.4	6.0	8.6	5.3	6.7	8.2
Total	5.1	6.0	7.0	5.9	7.4	9.0	5.5	6.8	8.1

Sources: Bureau of the Census, **U. S. Census of Population, 1960**, PC (1) 26C, Table 37, and **U. S. Census of Population, 1950**, Vol. II, Part 24, Table 53.

Table 5. Number and Percentage of Population in Age Groupings Below 65 and Over 65, Mississippi, 1940, 1950, and 1960.

Year	Below 65 years of age		65 years of age and over		Total Population
	No.	%	No.	%	No.
1940	2,068,378	94.7	115,418	5.3	2,183,796
1950	2,025,950	93.0	152,964	7.0	2,178,914
1960	1,990,598	91.4	187,543	8.6	2,178,141

Sources: Bureau of the Census, **U. S. Census of Population, 1960**, PC (1) 26C and **U. S. Census of Population, 1950**, Vol. II, Part 24, Table 15.

Considering the total aged population of the State, an increase of 22.6 per cent was observed. Both numerically and percentagewise, however, this gain was smaller for the last decade than for the preceding decade.

Interesting information was also revealed with respect to the residence of the older citizens. Both racial groupings suffered considerable losses of aged persons in the rural farm areas, while the rural nonfarm and urban categories experienced increases.

It may be assumed that a large part of the loss in rural farm population was due not to deaths but either to migration to urban areas, to reclassification from rural farm to rural nonfarm as a result of retirement, or to a redefini-

tion of these terms by the Bureau of the Census.⁴ Aged white persons were more likely to remain in farming than their nonwhite counterparts. The latter gained a larger proportion of aged rural nonfarm people during the decade 1950 to 1960 than the white population. In the urban areas the reverse was apparent.

Despite the decline in the aged rural farm population, the proportion 65 years of age and over, classified as farm operators, was higher in the 1959 Census of Agriculture than it was ten years earlier (Table 6). The average age of the Mississippi farm operator gradually increased from 43.6 in 1940 to 46.2 in 1950 to 51.4 in 1959, and to 52.8 in 1964.

Rural areas usually have a larger

⁴The 1950 Census of Agriculture defined a farm as a place of 3 or more acres on which the value of agricultural products in 1949, exclusive of home garden, amounted to \$150 or more. The agricultural products could have been either for home use or for sale. Places of less than 3 acres were counted as farms only if the value of sales of agricultural products in 1949 amounted to \$150 or more.

The 1960 Census defined the farm population as consisting of persons living in rural territory on places of 10 or more acres from which the sale of farm products amounted to \$50 or more in 1959, or on places of less than 10 acres from which the sales of farm products amounted to \$250 or more in 1959.

male than female population. This was true for the aged in the rural farm areas of the State, where the sex ratio⁵ was 110.5. In the rural nonfarm areas, however, it was considerably lower, namely, 89.7, while for the urban areas the figures followed the expected trend, with a sex ratio of 86.8. Thus, aged males were more likely to be found in the rural areas than their female counterparts, while in the rural nonfarm and urban areas the reverse was true.

Data indicated generally larger numerical and proportional increases for aged females than for aged males. Both sexes, however, had experienced losses in the rural farm areas. These losses were higher among the male population.

Considering the changes on a county basis, Table 7 shows trends in the aged farm and nonfarm populations for each of Mississippi's 82 counties. Without exception the counties experienced a decrease in aged rural farm residents. These decreases were also greater than in the previous decade. With respect to the rural nonfarm category, 28 counties registered losses of aged population ranging from 0.9 to 66.8 per cent, while in the remaining counties the aged population increased, percentagewise. The most striking changes were observed in Issaquena and Jefferson Davis Counties, where the proportion of senior citizens more than tripled, while the total population of these two counties had actually decreased during the decade from 1950 to 1960.

⁵Sex ratio refers to the number of males per 100 females.

Table 6. Age of Mississippi Farm Operators 1940, 1950, 1954, 1959, 1964.

Age	1940		1950		1954		1959*		1964	
	No.	%	No.	%	No.	%	No.	%	No.	%
Under 25	24,626	9.0	16,136	6.6	6,747	3.2	2,517	1.8	1,684	1.5
25-34	62,397	22.8	49,846	20.5	28,158	13.4	12,451	9.1	8,690	8.0
35-44	62,194	22.7	54,485	23.3	49,458	23.6	27,573	20.2	20,164	18.5
45-54	55,281	20.2	49,866	20.5	53,842	25.7	38,671	28.2	28,528	26.1
55-64	40,476	14.8	37,541	15.5	38,487	18.4	30,541	22.3	28,174	25.8
65 +	28,834	10.5	32,854	13.6	32,947	15.7	25,181	18.4	21,901	20.1
Average Age	43.6		46.2		48.2		51.4		52.8	
Total	273,808	100.0	242,728	100.0	209,639	100.0	136,934	100.0	109,141	100.0

Sources: Bureau of the Census, *U. S. Census of Agriculture, 1954*, Vol. I, Part 22; and 1959, Vol. I, Part 33; and 1964, Vol. I, Part 33.

*The change in number may be attributed partly to a change in definition of farm operator from 1950 to 1959.

The overall distribution of persons 65 years of age and over and the relation of this distribution to the State's average of aged persons (8.7 per cent) in 1960 is illustrated in Figures 1 and 2, respectively.

Changes Within Age Groupings

Comparison of the 1950 and 1960 figures, based on broad age groupings within the aged population, revealed that across the board there was a decrease in the proportion of people 65 to 69 years of age in relation to the total aged population. However, only in the rural nonwhite segment did this proportional decrease coincide with a numerical decrease.

Appraised on the same basis, the next category, i.e., those 70 to 74 years of age, showed little or no change, percentagewise. There was one exception, however, the rural nonwhite male category did increase numerically.

Both numerical and proportional increases were most pronounced in the highest age categories (Table 8).

Examining the same figures on the basis of the total 1950 population in each of the old age categories, a striking pattern appears, indicating disproportionately large increases in the 75 to 84, and especially, the 85 and over age category. In the urban areas, the white population in the latter age bracket increased 145 per cent, while the nonwhite doubled. An identical pattern was observed in the rural areas, although increases were not as pronounced (Tables 9 and 10).

Table 7. Percent Change in Population 65 Years Old and Over, Rural Farm and Rural Nonfarm Residence, 1940-1950 and 1950-1960, Counties, Mississippi.

Counties	Rural Farm		Rural Nonfarm	
	Percent change		Percent change	
	1940-1950	1950-1960	1940-1950	1950-1960
Adams	-28.7	-62.0	45.0	-64.8
Alcorn	-1.3	-22.6	95.1	-49.8
Amite	-2.7	-48.2	92.3	137.2
Attala	1.9	-43.2	73.7	2.8
Benton	7.5	-33.8	62.7	145.9
Bolivar	0.8	-21.2	107.9	9.8
Calhoun	16.2	-47.4	74.4	146.0
Carroll	-5.6	-35.0	104.2	86.3
Chickasaw	12.4	-35.7	40.8	-1.0
Choctaw	4.1	-57.0	109.2	149.3
Claiborne	-26.0	-45.5	120.7	-19.7
Clarke	-5.2	-44.6	91.3	86.8
Clay	-4.1	-30.9	63.4	-31.5
Coahoma	21.9	-59.7	84.8	-17.6
Copiah	-11.0	-39.7	85.2	-2.5
Covington	4.1	-25.8	138.2	99.8
DeSoto	14.3	-39.0	66.2	193.4
Forrest	-2.2	-48.9	69.6	-55.7
Franklin	-9.2	-62.4	69.9	88.9
George	16.8	-22.7	105.6	68.9
Greene	-8.1	-34.7	66.3	128.8
Grenada	-6.6	-21.3	64.7	-33.4
Hancock	64.5	-46.6	26.9	-6.1
Harrison	-10.3	-68.2	49.5	-65.5
Hinds	-20.2	-47.4	88.0	-66.8
Holmes	6.7	-46.4	60.4	32.1
Humphreys	9.1	-53.0	97.4	50.7
Issaquena	-5.8	-69.4	53.2	220.8
Itawamba	2.1	-25.4	484.4	149.7
Jackson	22.5	-64.1	69.9	-36.6
Jasper	22.5	-37.6	140.2	161.3
Jefferson	-4.7	-61.1	113.3	109.5
Jefferson Davis	21.6	-43.0	149.4	242.1
Jones	14.8	-47.4	86.4	-29.0
Kemper	-9.1	-32.6	69.0	143.3
Lafayette	9.4	-38.3	72.1	-9.0
Lamar	36.2	-44.8	50.0	114.1
Lauderdale	-6.4	-63.3	76.2	-64.3
Lawrence	8.4	-45.3	71.1	157.7
Leake	28.0	-26.0	78.5	173.3
Lee	4.7	-37.9	86.4	-13.6
Leflore	14.1	-26.8	72.1	-44.7
Lincoln	-2.9	-48.4	83.5	-0.9
Lowndes	-6.8	-32.7	77.1	-50.3
Madison	4.9	-30.8	85.9	-14.5
Marion	18.5	-27.1	107.2	15.4
Marshall	9.0	-27.3	42.0	9.3
Monroe	-19.7	-30.0	32.0	-31.5
Montgomery	1.7	-48.9	73.2	6.8
Neshoba	4.7	-16.8	130.6	38.4
Newton	8.9	-35.1	66.8	82.7
Noxubee	-9.6	-26.2	72.5	68.3
Oktibbeha	-7.8	-37.5	98.7	7.6
Panola	13.8	-23.1	126.8	37.4
Pearl River	31.2	-46.6	42.9	42.9
Perry	4.9	-36.7	59.1	95.6
Pike	-4.9	-46.0	54.2	-12.2
Pontotoc	14.0	-26.2	94.8	121.9
Prentiss	-1.4	-9.7	113.5	20.1
Quitman	30.7	-25.8	95.5	51.6
Rankin	6.6	-38.2	93.3	50.7
Scott	8.5	-27.5	94.5	46.8
Sharkey	5.1	-8.9	124.1	18.8
Simpson	20.2	-42.0	97.3	143.6
Smith	25.9	-16.8	85.3	166.7
Stone	16.3	-39.5	38.9	98.5
Sunflower	-7.5	-47.1	116.5	45.7
Tallahatchie	7.8	-41.6	72.3	65.9
Tate	5.4	-26.1	103.9	26.5
Tippah	-8.1	-9.9	122.5	5.8
Tishomingo	-6.3	-23.2	116.7	80.0
Tunica	24.2	-26.9	46.4	163.0
Union	15.3	-35.3	78.0	10.1
Walthall	15.5	-16.9	105.2	192.9
Warren	-14.8	-96.6	53.2	-61.0
Washington	16.9	-73.7	77.3	-53.5

(Continued on page 12)

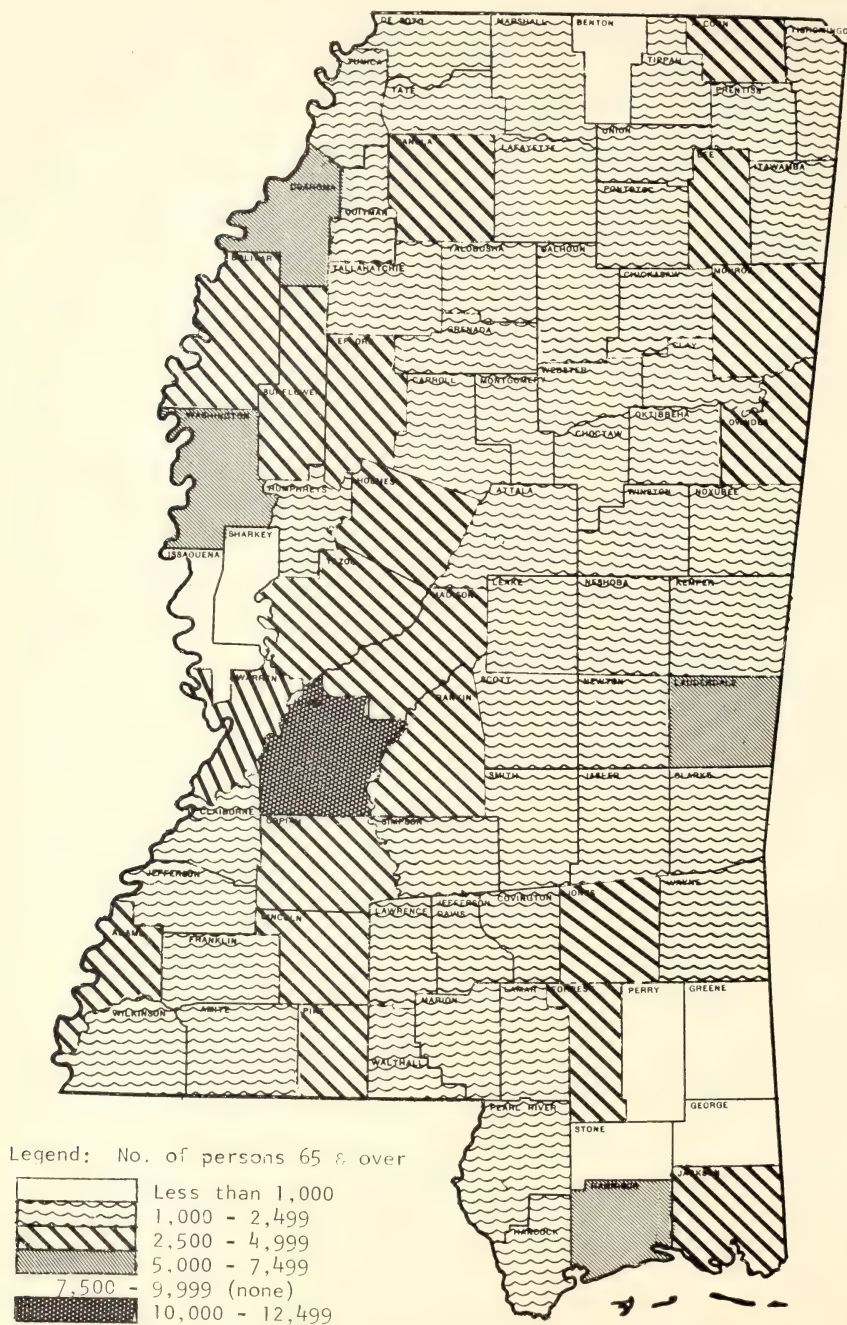


Figure 1. Number of aged persons in Mississippi counties, 1960.

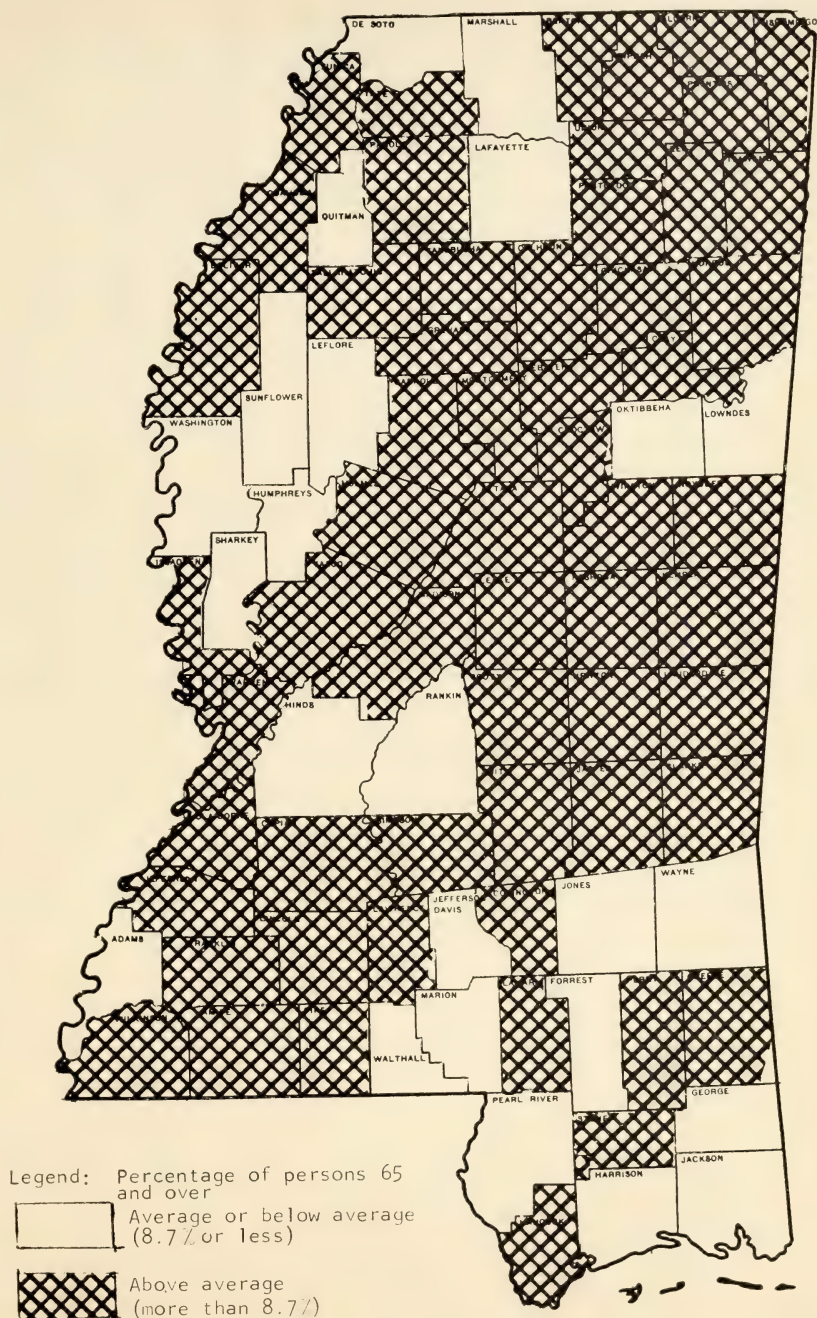


Figure 2. Percentage of aged persons in Mississippi counties, 1960, in relation to the State's average.

(Table 7 continued)

Counties	Fural Farm		Rural Nonfarm	
	Percent change		Percent change	
	1940-1950	1950-1960	1940-1950	1950-1960
Wayne	11.7	-44.0	55.6	70.1
Webster	8.6	-38.5	71.0	151.5
Wilkinson	-26.5	-64.4	99.2	96.1
Winston	18.7	-17.1	128.8	-4.1
Yalobusha	-7.1	-21.5	66.3	-35.7
Yazoo	-4.4	-40.7	81.4	-16.2
Mississippi	3.5	-37.7	77.8	94.2

Sources: Bureau of the Census, **U. S. Census of Population, 1950**, Vol. II, Part 24, and **U. S. Census of Population, 1960**, PC (1) 26D.

Table 8. Percentage Distribution of Age Groupings: Within Aged Population, by Race, Residence, and Sex, Mississippi, 1950 and 1960.

Characteristic	RURAL POPULATION						URBAN POPULATION					
	Male		Female		Total		Male		Female		Total	
	1950	1960	1950	1960	1950	1960	1950	1960	1950	1960	1950	1960
Total Aged Population:												
65-69	42.9	38.2	43.7	37.9	43.3	38.0	43.8	39.9	42.4	36.9	43.0	38.1
70-74	27.6	27.7	26.3	27.0	27.0	27.4	27.5	28.0	26.6	27.4	27.0	27.7
75-84	25.6	28.3	24.8	28.7	25.2	28.5	25.1	26.8	26.1	29.1	25.6	28.1
85 and over	3.9	5.8	5.2	6.4	4.5	6.1	3.6	5.3	4.9	6.6	4.4	6.1
All 65 & over	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
White:												
65-69	41.7	37.0	41.9	36.2	41.8	36.6	42.5	38.9	39.7	34.7	40.9	36.4
70-74	28.8	28.8	27.9	27.8	28.4	28.3	28.7	29.0	28.2	28.1	28.4	28.5
75-84	26.1	29.0	26.0	30.0	26.0	29.5	25.5	27.1	27.6	30.7	26.7	29.2
85 and over	3.4	5.2	4.2	6.0	3.8	5.6	3.3	5.0	4.5	6.5	4.0	5.9
All 65 & over	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Nonwhite:												
65-69	44.3	39.7	46.1	40.5	45.1	40.1	45.9	41.4	46.8	40.8	46.4	41.0
70-74	26.3	26.3	24.2	25.9	25.3	26.1	25.5	26.3	24.1	26.2	24.7	26.3
75-84	24.9	27.4	23.3	26.7	24.1	27.1	24.4	26.3	23.5	26.1	23.8	26.2
85 and over	4.5	6.6	6.4	6.9	5.5	6.7	4.2	6.0	5.6	6.9	5.1	6.5
All 65 & over	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Bureau of the Census, **U. S. Census of Population, 1960, Mississippi: General Population Characteristics**, PC (1) 26B, Table 16.

Percentages were calculated from figures given in the above source.

Table 9 Changes in Urban Population by Age Groupings Within Aged Population, by Race and Sex, Mississippi, 1950 to 1960.

Characteristic	U R B A N								
	Aged Male Population			Aged Female Population			Total Aged Population		
	1960	Change	1950-1960	1960	Change	1950-1960	1960	Change	1950-1960
	No.	No.	%	No.	No.	%	No.	No.	%
Total Population:									
65-69	11,024	3,389	44.4	14,227	4,228	42.3	25,251	7,617	43.2
70-74	7,744	2,958	61.8	10,568	4,282	68.1	18,312	7,240	65.4
75-84	7,411	3,046	69.8	11,205	5,057	82.3	18,616	8,103	77.1
85 and over	1,478	843	132.8	2,568	1,411	122.0	4,046	2,254	125.8
All 65 & over	27,657	10,236	58.8	38,568	14,978	63.5	66,225	25,214	61.5
White:									
65-69	6,579	2,068	45.8	8,653	2,800	47.8	15,232	4,868	47.0
70-74	4,914	1,864	61.1	6,991	2,844	68.6	11,905	4,708	65.4
75-84	4,579	1,872	69.2	7,641	3,572	87.8	12,220	5,444	80.3
85 and over	838	493	142.9	1,621	964	146.7	2,459	1,457	145.4
All 65 & over	16,910	6,297	59.3	24,906	10,180	69.1	41,816	16,477	65.0
Nonwhite:									
65-69	4,445	1,321	42.3	5,574	1,428	34.4	10,019	2,749	37.8
70-74	2,830	1,094	63.0	3,577	1,438	67.2	6,407	2,532	65.3
75-84	2,832	1,174	70.8	3,564	1,485	71.4	6,396	2,659	71.2
85 and over	640	350	120.7	947	447	89.4	1,587	797	100.9
All 65 & over	10,747	3,939	57.9	13,662	4,798	54.1	24,409	8,737	55.7

Source: Bureau of the Census, **U. S. Census of Population, 1960, Mississippi: General Population Characteristics**, PC (1) 26B., Table 16.

Table 10. Changes in Rural Population by Age Groupings Within Aged Population, by Race and Sex, Mississippi, 1950 to 1960.

Characteristic	R U R A L								
	Aged Male Population			Aged Female Population			Total Aged Population		
	1960	Change	1950-1960	1960	Change	1950-1960	1960	Change	1950-1960
	No.	No.	%	No.	No.	%	No.	No.	%
Total Population:									
65-69	23,179	-1,470	-6.0	23,885	44	0.2	47,064	-1,426	-2.9
70-74	16,866	994	6.3	17,031	2,715	19.0	33,897	3,709	12.3
75-84	17,228	2,526	17.2	18,072	4,574	33.9	35,300	7,100	25.2
85 and over	3,539	1,299	58.0	4,004	1,169	41.2	7,543	2,458	48.6
All 65 & over	60,812	3,349	5.8	62,992	8,502	15.6	123,804	11,851	10.6
White:									
65-69	13,254	237	1.8	13,828	1,098	8.6	27,082	1,335	5.2
70-74	10,300	1,334	14.9	10,612	2,118	24.9	20,912	3,452	19.8
75-84	10,374	2,226	27.3	11,437	3,543	44.9	21,811	5,769	57.4
85 and over	1,881	828	78.6	2,296	1,022	80.2	4,177	1,850	79.5
All 65 & over	35,809	4,625	14.8	38,173	7,781	25.6	73,982	12,406	20.1
Nonwhite:									
65-69	9,925	-1,707	-14.7	10,057	-1,054	-9.5	19,982	-2,761	-12.1
70-74	6,566	-340	-4.9	6,419	597	10.3	12,985	257	2.0
75-84	6,854	300	4.6	6,635	1,031	18.4	13,489	1,331	10.9
85 and over	1,658	471	39.7	1,708	147	9.4	3,366	618	22.5
All 65 & over	25,003	-1,276	-4.9	24,819	721	3.0	49,822	-555	-1.1

Source: Bureau of the Census, **U. S. Census of Population, 1960, Mississippi: General Population Characteristics**, PC (1) 26B, Table 16.

Size of Community

When rural and urban areas were arranged according to size, it was found that in 1960, 58.5 per cent of the rural aged population in Mississippi lived in places with less than 1,000 population, while 6.4 per cent resided in rural places with 1,000 to 2,500 inhabitants. Of those senior citizens who lived in urban areas, the majority lived in towns with a population of 10,000 or more (Table 11).

A comparison of the changes in distribution of the aged and of the total population from 1950 to 1960 in places

of different size is made in Tables 12, 13, and 14.

It can be readily observed that with few exceptions the aged population increased. Not only did it increase but even in cases where the total population showed losses, a gain was found in the aged category. The extremes in losses and gains were most often evident in places with a population of 1,000 to 2,500, followed by those with 2,500 to 10,000 inhabitants. None of the larger places, i. e. those 10,000 and over, registered a loss of population; but, the proportion gain in these towns

Table 11. Number and Percent in the Population 65 Years Old and Over, by Size of Place, Urban and Rural Residence, Sex, Mississippi, 1960.

Type of Residence	Males		Females		Total	
	Number	Percent	Number	Percent	Number	Percent
Rural						
Under 1,000	55,560	62.8	56,160	55.3	111,720	58.8
1,000 - 2,500	5,252	5.9	6,832	6.7	12,084	6.4
Total	60,812	68.7	62,992	62.0	123,804	65.2
Urban						
Central cities and	3,505	4.0	5,152	5.2	8,657	4.6
Urban fringe	48	—	72	—	120	—
2,500-10,000	9,600	10.9	13,292	13.1	22,892	12.0
10,000 or more	14,504	16.4	20,052	19.7	34,556	18.2
Total	27,657	31.3	38,568	38.0	66,225	34.8
Total, 65+*	88,469	100.0	101,560	100.0	190,029	100.0

Source: Bureau of the Census, **U. S. Census of Population, 1960, General Population Characteristics**, 26B, Table 16.

*The figures given differ from those listed in Vol. 26C, Table 37.

Table 12. Number and Percent Change in Population 65 Years of Age and Over, 1950-1960, by Sex, and in Total Population of Places in Mississippi with 1,000 to 2,500 Inhabitants in 1950.

Town	Aged population 1960		Changes in							
			Aged males 1950-1960		Aged females 1950-1960		Total Aged 1950-1960		Total Ages 1950-1960	
	Males	Females	No.	%	No.	%	No.	%	No.	%
Ackerman	103	112	23	28.8	31	38.3	54	33.5	—5.5	
Baldwin	111	162	33	42.3	74	84.1	107	64.4	29.0	
Batesville*	106	181	47	79.7	93	105.7	140	95.2	33.0	
Bay Springs	56	79	1	1.8	24	43.6	25	22.7	18.6	
Bear Town	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Brandon	72	72	22	44.0	23	46.9	45	45.4	17.1	
Bruce	86	79	46	115.0	35	79.5	81	96.4	—1.2	
Bude	62	63	25	67.6	26	70.3	51		—0.8	
Calhoun City	101	103	61	152.5	46	80.7	107	110.3	29.9	
Carthage	99	122	19	23.8	46	60.5	65	41.7	26.9	
Centerville**	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Clinton*	99	143	55	125.0	51	55.4	106	77.9	52.5	
Coldwater	69	90	NA	NA	NA	NA	NA	NA	33.2	
Collins	64	94	8	14.3	37	64.9	45	39.8	18.9	
Crenshaw	81	83	NA	NA	NA	NA	NA	NA	86.8	
Crosby	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Decatur	56	67	21	60.0	28	71.8	49	66.2	9.4	
D'Iberville*	69	77	39	13.0	50	185.2	89	156.1	110.3	
Drew	90	153	27	42.8	87	131.8	114	88.4	27.5	
Durant*	154	233	41	36.3	79	51.3	120	44.9	13.2	
East Side *	95	86	68	251.8	55	177.4	123	212.1	255.4	
Edwards	64	98	14	28.0	7	7.7	21	14.9	20.4	
Escatampa	43	58	NA	NA	NA	NA	NA	NA	NA	
Eupora	85	111	20	30.8	37	50.0	57	41.0	9.7	
Fayette	72	126	6	9.1	25	24.8	31	18.6	8.5	
Friars Point	88	96	NA	NA	NA	NA	NA	NA	NA	
Fulton	71	94	18	34.0	41	77.4	59	55.7	27.0	
Gloster*	75	94	5	7.1	5	5.6	10	6.3	—6.7	
Handsboro	64	44	NA	NA	NA	NA	NA	NA	NA	
Heidelberg	32	55	NA	NA	NA	NA	NA	NA	NA	
Hernando	82	117	25	43.1	45	62.5	70	53.8	57.4	
Hollandale*	158	186	44	46.8	74	66.1	118	57.3	12.8	
Houston*	116	168	49	73.1	92	121.0	141	98.6	54.9	
Inverness	48	84	10	26.3	48	133.3	58	78.4	2.9	
Itta Bena	132	164	34	34.7	40	32.2	74	33.3	11.0	
Iuka	114	140	34	42.5	38	37.2	72	39.6	31.6	
Kreole	36	35	14	63.6	15	75.0	29	69.0	69.1	
Lambert	68	106	0	0	47	79.7	47	37.0	15.5	
London-West										
Gulfport	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Leakesville	57	66	NA	NA	NA	NA	NA	NA	NA	
Lucedale	63	81	18	40.0	28	52.8	46	46.9	21.2	
Lumberton	95	108	23	31.9	21	24.1	44	27.7	16.9	
McComb (Smith)	80	96	NA	NA	NA	NA	NA	NA	NA	
Macon	112	188	31	38.3	48	34.3	79	35.7	8.5	
Magee	78	105	14	21.9	41	64.1	55	43.0	17.3	
Magnolia	102	136	22	27.5	48	54.5	70	41.7	5.0	
Marks*	135	161	57	73.1	53	49.1	110	59.1	16.4	
Mendenhall	86	103	22	34.4	43	71.7	65	52.4	26.4	
Mill/Moris Town	NA	NA	NA	NA	NA	NA	NA	NA	NA	
Monticello	52	66	9	20.9	28	73.7	37	45.7	3.6	
Moorhead	129	143	39	43.3	67	88.2	106	63.8	0.3	
Morton	74	111	29	64.4	47	73.4	76	69.7	35.8	
Mound Bayou	95	99	33	53.2	23	30.3	56	40.6	2.0	
Nettleton	66	94	14	26.9	26	38.2	40	33.3	15.4	
Okolona*	141	211	28	24.8	78	58.6	106	43.1	21.0	
Pelahatchie	49	59	NA	NA	NA	NA	NA	NA	NA	
Petal*	105	142	52	98.1	80	129.0	132	114.8	186.5	
Pontotoc	118	185	36	43.9	86	86.9	122	67.4	32.1	
Poplarville	90	112	11	13.9	23	25.8	34	20.2	15.3	
Prentiss	42	69	17	68.0	36	109.1	53	91.4	9.0	
Purvis	66	92	24	57.1	48	109.1	72	83.7	27.1	
Quitman	90	100	22	32.4	38	61.3	60	46.2	11.7	
Raymond	25	56	—17	—40.5	13	30.2	—4	—4.7	9.7	
Richton	52	63	1	2.0	16	34.0	17	17.3	—6.0	
Riley*	168	200	52	44.8	78	63.9	130	54.6	12.0	
Rolling Fork	46	51	—2	—4.2	3	6.2	1	1.0	31.7	
Rosedale	133	176	49	58.3	51	40.8	100	47.8	6.5	
Ruleville	114	147	37	48.0	85	137.1	122	87.8	25.0	
Sardis	119	136	45	60.8	22	19.3	67	35.6	9.7	
Senatobia*	131	211	52	65.8	84	66.1	136	66.0	54.6	
Shaw	138	200	23	20.0	44	28.2	67	24.7	9.0	
Shelby	140	203	45	47.4	58	40.0	103	42.9	11.0	

(continued next page)

(Table 12. continued)

Town	Aged population 1960		Aged males 1950-1960		Aged females 1950-1960		Total Aged 1950-1960		Total All Ages 1950-1960	
	Males	Females	No.	%	No.	%	No.	%	No.	%
Stonewall	21	43	6	40.0	21	95.4	27	73.0	10.9	
Summit	68	109	—9	—11.7	27	32.9	18	11.3	6.7	
Taylorville	53	61	19	55.9	22	56.4	41	56.2	1.4	
Tie Plant	54	56	NA	NA	NA	NA	NA	NA	NA	
Tunica	67	83	32	91.4	20	31.7	52	53.1	6.7	
Tunica North	44	56	NA	NA	NA	NA	NA	NA	NA	
Tylertown	82	117	21	34.4	52	80.0	73	57.9	15.1	
Union	91	124	38	71.7	49	65.3	87	68.0	10.7	
Waveland	100	76	NA	NA	NA	NA	NA	NA	NA	
Wesson	57	89	—1	—1.7	20	29.0	19	15.0	—6.3	
Wiggins	69	96	16	30.2	36	60.0	52	46.0	10.8	
Woodville	63	98	18	40.0	27	38.0	45	38.8	15.4	

*Had more than 2,500 inhabitants in 1960, but not in 1950.

**The revised population total for Centerville in 1960 was 508 more than the number quoted in the Census. Among those are a number of aged people. Actual corrected figures by age breakdown are not available at this time.

NA Not available.

Sources: Bureau of Census, **U. S. Census of Population, 1950**, Part 24, p. 58, Table 40; **U. S. Census of Population, 1960**, PC 26B, pp. 47-48, Table 24. George L. Wilber and Ellen Bryant, **Growth of Mississippi Counties and Cities, 1950-1960**, AES Bulletin 608, December, 1960, Table 3.

was larger in the aged category than in the age groupings below 65. This, with few exceptions, was true for Mississippi as a whole, in that generally places which gained population had larger increases in the aged than in the other age categories.

This observation should be of profound interest to those who are engaged in action programs designed to meet the needs of a changing population.

It is also interesting to note, that according to the 1960 Census a large proportion of the State's aged population, 84 per cent, were native Mississippians.⁶ The majority of the non-native aged residents were born in another southern state.

Ninety-seven per cent of the aged residents also lived in Mississippi five years ago, and almost three-fourths reported they lived in the same house at that time.⁷ Only a slightly larger proportion of the white than nonwhite senior citizens reported out-of-state residence in 1955.⁸

Marital Status

Despite the numerical increase of aged persons in the State from 1950 to 1960, the proportion in each of the marital status groupings was remarkably similar to that of a decade ago: 55.1 per cent were married; 39 per cent widowed; 4.7 per cent single, and 1.2 per cent divorced.

Where changes did occur, they were most pronounced in the rural non-farm population. The latter showed the greatest proportional decrease in the widowed category, and the largest proportional increases in both the married and divorced segments of the population.

In the rural farm category, even though there were fewer widowers in 1960 than in 1950, the proportion of widowers in relation to all males 65 and over had increased over the decade.

Housing

In 1960, the Bureau of the Census realized the importance of the housing of this country's senior citizens, and, therefore, published a volume devoted solely to this subject.⁹ It included

⁶Bureau of the Census, **U. S. Census of Population, 1960, State of Birth**, PC (2), 2A, Table 25.

⁷Bureau of the Census, **U. S. Census of Population, 1960, Detailed Characteristics**, PC (1), 26D, Table 100.

⁸Bureau of the Census, **U. S. Census of Population, 1960, Lifetime and Recent Migration**, PC (2), 2D, Table 6.

⁹Bureau of the Census, **U. S. Census of Housing, 1960, Housing of Senior Citizens**, Vol. VII.

persons 60 years of age and over¹⁰ and subdivided them into categories as follows:

Those where the age of the head of the household was:

1. Under 60 years of age
2. 60 to 64 years of age
3. 65 to 74 years of age, and
4. 75 years of age and over.¹¹

¹⁰This in itself may be a significant factor in that usually a person 65 years of age or over was included in the "old age" category. Inclusion of the 60-64 age grouping may well be considered as a reclassification of the aged.

¹¹Inasmuch as the age limit employed up until this point was 65 and over, only the latter two groupings will be included for discussion.

The housing arrangements of the latter two groupings are presented in Table 15.

Seventy per cent of the aged population in Mississippi resided in owner-occupied units, while the remainder lived in renter-occupied units. Two-thirds of the former were occupied by couples who had no nonrelatives living

Table 13. Number and Percent Change in Population 65 Years of Age and Over, 1950-1960 by Sex, and in Total Population of Places in Mississippi, with 2,500 to 10,000 Inhabitants in 1950.

Town	Aged Population 1960		Changes in					
	Males	Females	Aged Males		Aged Females		Total Aged	Total All Ages
			1950-1960		1950-1960		1950-1960	1950-1960
	No.	No.	No.	%	No.	%	No.	%
Aberdeen	275	399	51	22.8	92	30.0	143	26.9
Amory	300	401	111	58.7	157	64.3	268	61.9
Bay St. Louis	274	345	90	48.9	113	48.7	203	48.8
Belzoni	184	230	41	28.7	87	60.8	128	44.8
Booneville	157	253	41	35.3	92	57.1	133	48.0
Brookhaven	364	557	119	48.6	239	75.2	358	63.6
Canton	405	597	142	54.0	238	66.3	380	61.1
Charleston	145	238	42	40.8	93	64.1	135	54.4
Cleveland*	309	412	142	85.0	172	71.7	314	77.1
Columbia	291	363	114	64.4	152	72.0	266	68.6
Corinth	585	820	148	33.9	306	59.5	454	47.7
Crystal Springs	209	286	72	52.6	81	39.5	153	44.7
Ellisville	135	194	55	68.8	80	70.2	135	69.6
Forest	154	198	58	60.4	77	63.6	135	62.2
Greenville								
North	49	57	NA	NA	NA	NA	NA	NA
Grenada	325	484	122	60.1	176	57.1	298	58.3
Hazlehurst	157	247	45	40.2	61	32.8	106	35.6
Holly Springs	216	311	116	116.0	142	84.0	258	95.9
Indianola	305	407	148	94.3	178	77.7	326	84.4
Kosciusko	340	441	111	48.5	112	34.0	223	40.0
Leland	240	340	105	77.8	156	84.8	261	81.8
Lexington	156	224	21	15.6	44	24.4	65	20.6
Long Beach	211	237	114	117.5	109	85.2	223	99.1
Louisville	223	274	66	42.0	55	25.1	121	32.2
Miss. City	102	132	-9	-8.1	2	1.5	-7	-2.9
Moss Point	158	190	24	17.9	43	29.2	67	23.8
New Albany	272	377	137	101.5	162	75.3	299	85.4
Newton	133	177	52	64.2	69	63.9	121	64.0
Ocean Springs	182	240	68	59.6	68	49.6	171	68.1
Oxford	204	324	65	46.8	114	54.3	179	51.3
Pass Christian	173	246	33	23.6	75	43.8	108	34.7
Pearl	40	62	NA	NA	NA	NA	NA	NA
Philadelphia	222	262	78	54.2	112	74.7	190	64.6
Picayune	278	293	119	74.8	137	87.8	256	81.3
Port Gibson	124	188	3	2.5	16	9.3	19	6.5
Starkville	227	387	74	48.4	136	54.2	210	52.0
University	6	15	NA	NA	NA	NA	NA	NA
Water Valley	233	354	45	23.9	113	46.9	158	36.8
Waynesboro	119	146	11	10.2	20	15.9	31	13.2
West Gulfport	69	67	NA	NA	NA	NA	NA	NA
West Point	281	472	65	30.1	98	26.2	163	27.6
Winona	205	278	68	49.6	74	36.3	142	41.6
Yazoo City	459	738	156	51.5	251	51.5	407	51.5

Sources: Bureau of the Census, **U. S. Census of Population, 1950, Characteristics of the Population**, Vol. II, Part 24, pp. 52-54, Table 38.

Bureau of the Census, **U. S. Census of Population, 1960, General Population Characteristics**, PC (1) 26B, pp. 43-46, Table 22.

George L. Wilber and Ellen Bryant, **Youth of Mississippi Counties and Cities, 1950 to 1960**, Mississippi AES Bulletin 608, December 1960, pp. 6-7.

*Indicates total population more than 10,000 in 1960.

NA — Not available.

Table 14. Changes in Population 65 Years Old and Over, 1950-1960, of Places with 10,000 or More Inhabitants in 1950, by Sex and Race, Mississippi.

Town	Aged Population		Changes from 1950-1960					
	1960		Aged Males		Aged Females		Total	
	Males	Females					Aged	All Ages
	No.	No.	No.	%	No.	%	%	%
Biloxi								
White	1,044	810	438	72.3	179	28.4		
Nonwhite	116	134	26	28.9	5	3.9		
Total	1,160	944	464	66.7	184	24.2	44.5	17.7
Clarksdale								
White	353	513	144	68.9	227	79.4		
Nonwhite	555	626	238	75.1	251	66.9		
Total	908	1,139	382	72.6	478	72.3	72.4	27.6
Columbus								
White	405	680	148	57.6	261	62.3		
Nonwhite	336	452	111	49.3	140	44.9		
Total	741	1,132	159	53.7	401	54.8	54.4	44.3
Greenville								
White	450	702	139	44.7	291	70.8		
Nonwhite	785	1,066	238	43.5	354	49.7		
Total	1,235	1,768	377	43.9	645	57.4	51.6	38.9
Greenwood								
White	302	528	97	47.3	182	52.6		
Nonwhite	487	580	185	61.2	204	54.2		
Total	789	1,108	282	55.6	386	53.5	54.4	13.1
Gulfport								
White	824	903	299	57.0	353	64.2		
Nonwhite	161	193	29	22.0	66	52.0		
Total	985	1,096	328	49.9	419	61.9	56.0	33.3
Hattiesburg								
White	745	1,204	232	45.2	517	75.2		
Nonwhite	415	447	169	68.7	160	55.7		
Total	1,160	1,651	401	52.8	677	69.5	62.2	18.7
Jackson								
White	2,169	3,584	894	70.1	1,562	77.2		
Nonwhite	1,336	1,568	489	57.7	503	47.2		
Total	3,505	5,152	1,383	65.2	2,065	66.9	66.2	47.0
Laurel								
White	594	829	187	45.9	301	57.0		
Nonwhite	318	364	69	27.7	128	54.2		
Total	912	1,193	256	39.0	429	56.2	48.2	11.4
McComb								
White	430	622	109	34.0	194	45.3		
Nonwhite	104	136	35	50.7	53	63.8		
Total	534	758	144	36.9	247	48.3	43.4	15.6
Meridian								
White	1,329	2,161	382	40.3	799	58.7		
Nonwhite	561	839	160	39.9	291	53.1		
Total	1,890	3,000	542	40.2	1,090	57.1	50.1	17.9
Natchez								
White	301	518	36	14.4	109	26.6		
Nonwhite	401	618	91	29.4	75	13.8		
Total	702	1,136	129	22.5	184	19.3	20.5	4.6
Pascagoula								
White	292	367	113	63.1	154	72.3		
Nonwhite	69	82	28	68.3	29	54.7		
Total	361	449	141	64.1	183	68.8	66.7	58.6
Tupelo								
White	373	627	121	48.0	280	80.7		
Nonwhite	189	185	59	45.4	28	17.8		
Total	562	812	180	47.1	308	61.1	55.1	49.4
Vicksburg								
White	557	953	125	28.9	266	38.7		
Nonwhite	655	943	138	26.7	242	34.5		
Total	1,212	1,896	263	27.7	507	36.6	33.0	4.2

Sources: Bureau of the Census. **U. S. Census of Population, 1960, General Population Characteristics**, PC (1) 26E, pp. 36-40, Table 20.

U. S. Census of Population, 1950, Characteristics of the Population, Vol. II, Part 24, pp. 40-42, Table 33.

George L. Wilber and Ellen Bryant, **Growth of Mississippi Counties and Cities, 1950-1960**, Mississippi AES Bulletin 608, December, 1960, pp. 6-7.

with them, one-fourth had a family head, while the remainder had other arrangements.

A slightly different pattern was found for the renter-occupied units, where 58 per cent were occupied by an aged male head with wife present and no nonrelatives; 27 per cent were households with an aged female head, and 15 percent had other arrangements.

¹²The employment data refer to the calendar week prior to the date on which the responses were received. Employed persons comprise those who did any work for pay or profit, or worked without pay for 15 hours or more on a family farm or in a family business, or were "with a job but not at work."

Table 15. Heads of Household 65 Years Old and Over by Owner or Renter—Occupied Units, Mississippi, 1960.

Age of head and household composition	Owner-occupied units		Renter-occupied units		All occupied units	
	Number	Percent	Number	Percent	Number	Percent
With head 65-74	77,293		33,222		110,515	
Male head, wife present, no nonrelatives	53,300	69.0	19,660	59.2	72,960	66.0
Other male head	6,171	8.0	4,848	14.6	11,019	10.0
Female head	17,822	23.0	8,714	26.2	26,536	24.0
With head 75 and over	37,632		16,101		53,733	
Male head, wife present, no nonrelatives	22,445	59.6	8,917	55.4	31,362	58.4
Other male head	4,717	12.5	2,658	16.5	7,375	13.7
Female head	10,470	27.9	4,526	28.1	14,996	27.9
TOTALS	114,925		49,323		164,248	

Source: Bureau of the Census, U. S. Census of Housing, 1960, Housing of Senior Citizens, Vol. VII, Table A-1.

Table 16. Employed Persons, 65 Years of Age and Over, by Occupation* and Sex, Mississippi, 1950 and 1960.

Occupation	1950				1960			
	Male		Female		Male		Female	
	No.	%	No.	%	No.	%	No.	%
Professional, technical and kindred workers	1,498	4.0	467	7.9	1,380	5.1	877	10.2
Farmers and farm managers ..	22,361	59.2	1,249	21.1	10,435	38.8	486	5.6
Managers, officials, and proprietors, exc. farmers	2,604	6.9	346	5.8	2,676	9.9	622	7.2
Clerical and kindred workers ..	652	1.7	231	3.9	1,034	3.9	641	7.4
Sales workers	1,130	3.0	288	4.9	1,316	4.9	628	7.3
Craftsmen, foremen, and kindred workers	1,874	5.0	26	0.4	1,865	6.9	22	0.3
Operatives, kindred workers ..	1,024	2.7	353	6.0	1,321	4.9	661	7.7
Private household workers	117	0.3	1,495	25.2	90	0.3	2,701	31.4
Service workers exc. private household..	1,180	3.1	473	8.0	1,487	5.5	871	10.1
Farm laborers and foremen	2,823	7.5	742	12.5	2,949	11.0	544	6.3
Laborers, exc. farm and mine	2,061	5.4	33	0.5	1,923	7.2	45	0.5
Occupation not reported	460	1.2	223	3.8	441	1.6	513	6.0
Total Employed	37,784	100.0	5,926	100.0	26,917	100.0	8,611	100.0
Total Aged	74,884		78,080		87,307		100,236	

Sources: Bureau of the Census, U. S. Census of Population, 1950, Characteristics of the Population, Vol. II, Part 24, Mississippi, Table 76, and U. S. Census of Population, 1960, Detailed Characteristics, PC (1), 26D, Mississippi, Table 123.

*Persons with two or more jobs during a survey week are classified as employed in the industry and at the occupation in which they worked the greatest number of hours during the week. Consequently, some of these shown as engaged in agricultural activities also engaged in nonagricultural activities, and vice versa.

The 1960 Census also reported that 2,742 aged residents of Mississippi (less than 2 per cent) lived in nursing homes. Three-fifths of these inhabitants were males and the remainder females.

Employment¹² and Occupation

Census figures reveal that fewer people 65 years of age and over were employed in 1960 than a decade ago. With

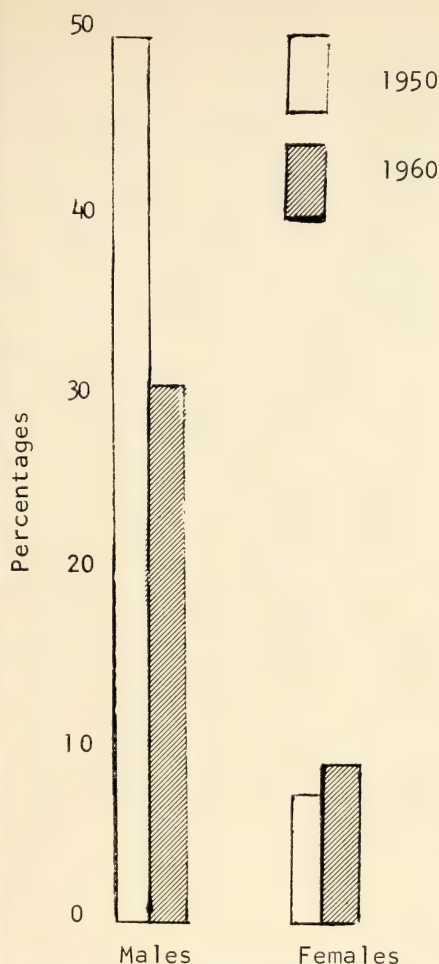


Figure 3. Percent of Aged Population in the Labor Force, 1950 and 1960, by Sex.

respect to the aged males, for example, 50 per cent were employed in 1950, while in 1960, 34 per cent were employed. Despite a numerical increase in the aged males, also the number employed was smaller. The data for the aged female population showed a different pattern. A small proportion of the latter was employed. However, changes over the decade went in the opposite direction from those of the males. In 1960 a larger proportion was employed than in 1950, the percentages

being 8.6 and 7.6, respectively (Figure 3). One may conclude that, with the increased independence of women, changes in this direction may be expected to continue for the next few decades. Starting out in a career when young may give women a strong incentive, and once momentum is gained, they may continue to work after retirement age.

In 1960, a very small proportion (4 per cent) of Mississippi's aged male and female population was unemployed, that is, was reported interested in a job but could not locate one. Table 16 illustrates the types of occupations in which these people were engaged, together with the trends of the past decade.

Of the total employed population in Mississippi in 1960, including all ages, the highest median age was reported in the following occupations:

	Median Age
Railroads and railway express service	50.3
Farm and farm managers	51.3
Barbers	51.6
Locomotive engineers	54.8
Guard and watchmen	56.4
Blacksmiths, forgemen, hammermen	61.8

Some of the above occupations are obviously becoming outmoded, especially the latter.

Income

Of the 110,296 heads of households, 65 years old and over, 5,102 or about 5 per cent, had no income at all in 1959; almost 33 per cent made from one to 499 dollars or registered a loss, and 28 per cent made from 500 to 999 dollars. These three categories thus included almost two-thirds of the State's aged heads of households (Table 17).

This low-income aged population, thus must depend for support on sources such as friends, relatives, and/or private or public agencies. This problem is expected to continue for at least a number of years to come. In 1961, the Federal Government spent, or administered, \$15 billion for the economic welfare of persons 65 years of age and over¹³ of which the Mississippi aged population received its share.

¹³Federal Council on Aging, 1962 Report to the President: How the Government Works for Older People (Washington, D. C.: U. S. Government Printing Office, 1962), p. 1.

Table 17. Income of Heads of Households, Age 65 and Over, Mississippi, 1960.

Income in 1959	Household heads age 65 and over	
	Number	Percent
None	5,102	4.6
\$1 to 499 or a loss	35,506	32.2
\$500 to 999	30,830	28.0
\$1,000 to 1,499	13,476	12.2
\$1,500 to 1,999	8,254	7.5
\$2,000 to 2,499	5,000	4.5
\$2,500 to 2,999	2,505	2.3
\$3,000 to 4,999	5,003	4.5
\$5,000 or more	4,620	4.2

Source: Bureau of the Census, **U. S. Census of Housing, 1960, Housing of Senior Citizens**, Vol. VII, Table A-4, p. 189.

CONCLUSION

The changing conditions in the many facets of social life profoundly affect not only youth but also the aged. To meet their respective needs, one must plan. One way in which such planning may be facilitated is by estimating

changes in population between Census years. Table 18 shows provisional estimates of the aged population for the year 1965. Another aid may be found in the projection of changes for the near and more distant future. George L. Wilber and Ellen S. Bryant have projected that by the year 1975 the aged population of the State will have increased to the effect that it will comprise 10 per cent of the total population. Their calculations show a possible increase of between 35 and 50 per cent in aged persons per se from 1960 to 1985. The increases are expected to continue to be considerably higher for the white than from the nonwhite population.¹⁴ These figures suggest a need for community planning to meet the problems of the aged.

¹⁴George L. Wilber and Ellen S. Bryant, **Illustrative Projections of Mississippi Population, 1960-1985**, State College, Miss.; Sociology and Rural Life Series No. 14, September, 1964.

Table 18. 1965 Estimates of Population 65 Years of Age and Over, for Mississippi, by County and Race.

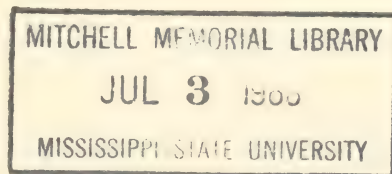
County	Total	White	Nonwhite	County	Total	White	Nonwhite
Adams	2,894	1,327	1,567	Lincoln	2,770	2,065	705
Alcorn	2,992	2,657	335	Lowndes	3,634	2,234	1,400
Amite	1,386	855	531	Madison	2,922	1,172	1,750
Attala	2,444	1,792	652	Marion	2,099	1,400	699
Benton	755	601	154	Marshall	2,032	800	1,232
Bolivar	4,893	1,483	3,410	Monroe	3,368	2,319	1,049
Calhoun	1,451	1,276	175	Montgomery	1,704	1,217	487
Carroll	1,181	686	495	Neshoba	2,533	2,194	339
Chickasaw	2,035	1,330	705	Newton	2,402	1,695	707
Choctaw	1,114	943	171	Noxubee	1,490	471	1,019
Claiborne	866	246	620	Oktoberbeha	2,148	1,233	915
Clarke	1,887	1,250	637	Panola	2,745	1,396	1,349
Clay	1,757	819	938	Pearl River	1,968	1,588	380
Coahoma	4,329	1,585	2,744	Perry	897	637	260
Copiah	3,036	1,790	1,246	Pike	3,489	2,350	1,139
Covington	1,316	874	442	Pontotoc	2,151	1,918	233
DeSoto	1,992	877	1,115	Prentiss	1,900	1,700	200
Forrest	4,213	3,051	1,162	Quitman	1,897	702	1,177
Franklin	898	553	345	Rankin	4,380	3,240	1,140
George	809	695	114	Scott	2,118	1,417	701
Greene	1,016	846	170	Sharkey	820	286	534
Grenada	1,670	880	790	Simpson	2,120	1,600	520
Hancock	1,724	1,499	225	Smith	1,416	1,234	182
Harrison	8,049	6,625	1,424	Stone	776	648	128
Hinds	13,073	7,768	5,305	Sunflower	3,749	1,355	2,394
Holmes	3,246	1,004	2,242	Tallahatchie	2,393	972	1,421
Humphreys	1,802	531	1,271	Tate	1,848	905	943
Issaquena	267	79	188	Tippah	1,921	1,610	311
Itawamba	1,652	1,592	60	Tishomingo	1,814	1,741	73
Jackson	3,056	2,597	459	Tunica	1,421	270	1,151
Jasper	1,979	1,324	655	Union	2,009	1,742	267
Jefferson	1,369	527	842	Walshall	1,139	814	325
Jefferson Davis	1,233	580	653	Warren	4,446	2,144	2,302
Jones	4,469	3,400	1,069	Washington	6,414	2,439	3,975
Kemper	1,451	944	507	Wayne	1,473	1,073	400
Lafayette	1,613	1,203	410	Webster	1,339	1,140	199
Lamar	1,230	859	371	Wilkinson	1,170	464	706
Lauderdale	7,255	5,391	1,864	Winston	1,750	1,213	537
Lawrence	1,091	722	369	Yalobusha	1,725	1,152	573
Leake	2,104	1,504	600	Yazoo	3,186	1,460	1,726
Lee	3,643	2,795	848				
Leflore	3,887	1,652	2,235	TOTALS	200,685	124,022	75,663

Source: These provisional estimates were computed by Mrs. Ellen S. Bryant, Division of Sociology and Rural Life, Mississippi Agricultural Experiment Station. The figures are subject to revision.

COSTS AND RETURNS TO GRADE "A" DAIRY FARMS IN MISSISSIPPI

by

Terry N. Roberts and Verner G. Hurt



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MISSISSIPPI

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SUMMARY

The 30 Grade "A" dairy farms studied sold over one-half million pounds of milk per farm during 1966. Milk sales per cow averaged slightly over 9,000 pounds from the average of 60 cows per farm.

Investment in the dairy enterprise per farm averaged slightly over \$79,500. Investment per cow averaged almost \$1,340. About 55 percent of the total investment was in land, buildings and improvements. Since the investment figures reported in most cases represented purchase price less depreciation, the replacement or market value of the investment in the dairy enterprise was likely somewhat greater than \$79,500 per farm.

Gross income from the dairy enterprise averaged \$36,678 per farm, Figure 1. Residual returns to the farmer and his family for their labor and management from the dairy enterprise averaged \$4,990. By herd size, residual returns ranged from the \$3,186 average for farms with 66 or more cows to \$6,910 for farms with 46-65 cows. By comparison, weekly gross earnings of workers in all manufacturing establishments in the U. S. in 1966 averaged \$111.92.^{1/} Based on working 50 weeks, these gross earnings annually would amount to almost \$5,600.

Per hundredweight of milk, net returns to unpaid family and operator labor and management averaged 92 cents. New returns per hundredweight were about 90 cents lower on the farms with more than 65 cows as compared to farms with 65 cows or less--\$0.38 as compared to about \$1.30. Farms in the smaller sizes tended to be specialized dairy farms utilizing operator and family labor. The value of this labor was not included as a cost item. The dairy enterprise on the larger farms was only a part of the overall operation and as such utilized relatively smaller proportions of operator and family labor (non-cost items) and larger proportions of hired labor (cost item). This practice plus the increased substitution of machinery and equipment for labor on the large farms was to a great extent responsible for the differences in net returns.

Purchased feed was the most important single cost item on the farms studied averaging \$2.04 per hundredweight of milk sold and accounting for 38 percent of the total cost. Depreciation, interest paid, insurance and taxes accounted for another 17 percent of the total amounting to almost 90 cents per hundredweight. Total production costs averaged \$5.32 per hundredweight of milk sold.

Even though average net returns per hundredweight to unpaid family and operator labor and management were lowest on the largest farms, net returns to the total farm operation were highest--\$8,383 as compared to \$7,833 for farms with 46-65 cows and \$4,599 for farms with 45 or fewer cows. The dairy enterprise accounted for only 38 percent of the farm net revenue on the largest farms as compared with more than 80 percent on the small and medium herd-size farms.

^{1/} U. S. Department of Commerce, Office of Business Economics, "Survey of Current Business", Vol. 47, No. 7, July 1967.

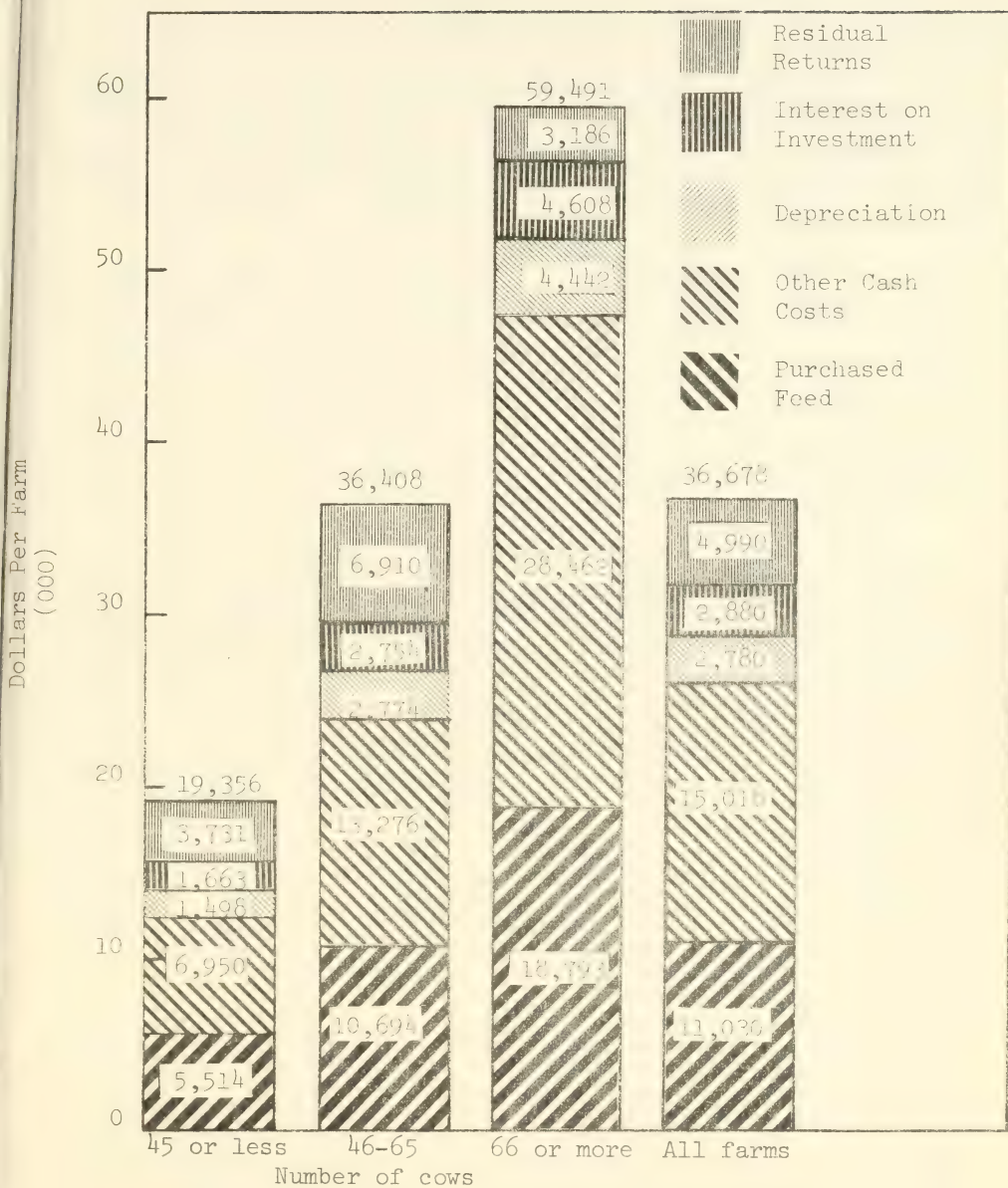


Figure 1. Distribution of total income to the dairy enterprise, by herd size 30 Grade "A" dairy farms, Mississippi, 1966.

CHAPTER I

INTRODUCTION

Dairy farming in Mississippi has changed phenomenally within the past decade or so. The number of herds decreased by more than 45 percent from 4,198 on January 1, 1957, to 2,304 herds on the same date in 1966.^{1/} Increases in herd size and in production per cow have more than offset the decrease in herd numbers. Consequently, the volume of Grade "A" milk marketed in Mississippi has increased.

Prices received by producers of fluid milk in Mississippi are regulated by the Mississippi Milk Commission. Often times, in their deliberations, there is a need for information relative to the organization of dairy farms and the cost of producing Grade "A" milk. In an effort to obtain equitable guides for its regulatory activities, the Commission requested that the Department of Agricultural Economics, Mississippi State University, conduct a study of the cost of producing Grade "A" milk in the state. Results of that study are reported in this publication.

Objectives

The objectives of this study were: (1) To estimate the cost and returns to Grade "A" dairy farmers in Mississippi, and (2) To examine the relationship between cost and returns and herd size.

Procedure

This study is based on records submitted by Mississippi Grade "A" dairy farmers to the Mississippi Electronic Farm Record Management Service, better known as MISSELFARMS. MISSELFARMS maintains, for the farmer, a complete set of costs and returns records classified by enterprises. In addition, a detailed beginning of the year inventory of all assets is required. This information, along with during-the-year additions and deletions is used to compute yearly depreciation on each item, total depreciation for the year, average farm investment, and net worth. For this work MISSELFARMS utilized the computing facilities of Mississippi State University.

As 1966 was the first year for the MISSELFARMS program, there were some errors in allocating costs and returns to the various enterprises, and some records were not completed satisfactorily. In order to correct these deficiencies, a personal interview was arranged with each of the farmers and any question about the records was clarified. Information pertaining to labor requirements, machinery and equipment requirements and buildings available was also obtained from the farmer on these visits.

1/ Harrington, Burton and Trammell, David, Dairy Marketing Statistics, Cooperative Extension Service, Mississippi State University, 1966, Table 7, p. 15.

All of the farms were not specialized dairy farms. Thus efforts were made to exclude the influence of cash enterprises other than dairy in the comparison of various farm characteristics as well as in comparisons of cost and returns. In cases where machinery, equipment, or buildings were used for both dairy and a non-dairy enterprise, percentages of investment and costs were allocated to the dairy enterprise. These percentages were based upon the farmers' records, personal interviews, and enterprise budgets developed by the staff of the Department of Agricultural Economics, Mississippi State University.

A sample of 200 Grade "A" dairy farms was selected initially and solicited for participation in the MISSELFARMS program for this study. Of this number, 34 enrolled. However, only 30 of the farmers' records were complete and in sufficient detail to be used in the study. Thus the study was based on 30 farms located throughout the state. The counties in which the farms were located and the number of sample farms per county are shown in Figure 2.

Since production cost can normally be expected to differ with herd size, the sample farms were grouped for the analysis into three size categories; those with milking herds of 45 or fewer cows, those with 46-65 cows, and those with a larger number.

Descriptive characteristics for each size group, presented in Appendix A, were reduced to a per cow basis by dividing the totals of the various items for each size group by the number of cows in each size category. Cost and returns per hundredweight of milk sold were also calculated in order that additional comparisons could be made among the various farm size groups.

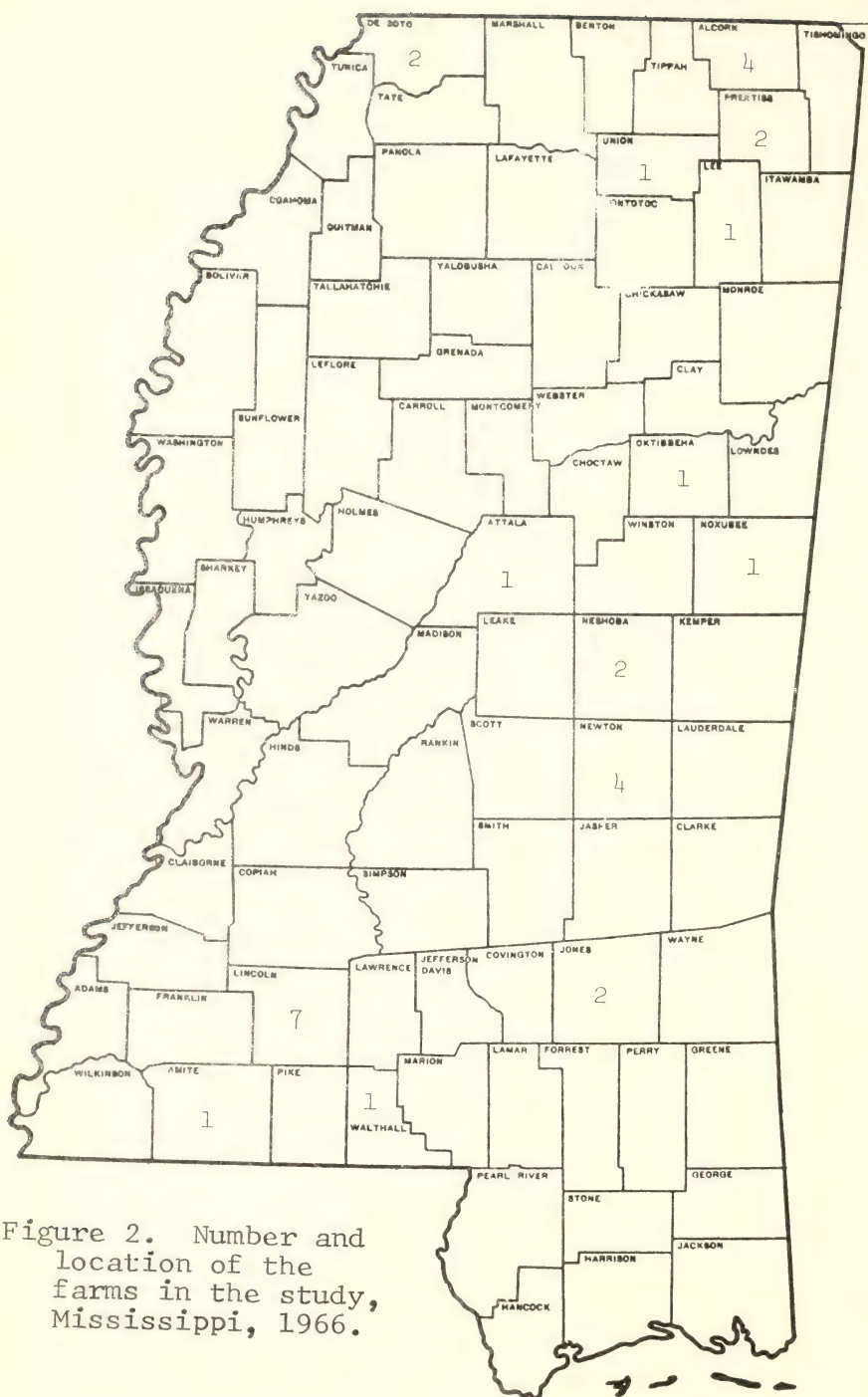


Figure 2. Number and location of the farms in the study, Mississippi, 1966.

CHAPTER II

FARM DESCRIPTION

Farm organization and the dairy facilities available on the farms studied were quite variable. On one extreme were farms with old stanchion milk barns, bucket milkers, manual feeding facilities for both roughages and concentrates, and a minimum of service buildings. On the other extreme were farms with herring-bone milk barns, pipe-line milkers, completely automatic feeding facilities for both concentrates and roughages, concrete feed lots and loafing areas, and free-stall housing for the dairy herd.

All farmers included in the study depended on farm-raised feed as the major source of roughage. However, the type of roughage used on the farm varied from an all-hay program to an all-silage program. Most of the farmers bought all concentrates used on the farm, although some, particularly the operators of small dairies, relied on farm-grown grain as the major source of concentrates.

Holsteins or the other large breeds were predominate on the farms studied. However, there were some all-Jersey herds and some herds that were mixtures of the large and small breeds.

Selected Characteristics

The 9 small farms averaged 35 cows in the milking herd, Table 1. The 14 farms in the next size category had an average of 57 cows per farm. The 7 large farms (more than 65 cows in the milking herd) had an average of 96 cows per farm.

Table 1. Number of farms and average number of cows milked per farm, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	Number of cows			All farms
	: 45 or less:	45-65	: 66 or more :	
Number of farms	9	14	7	30
Number of cows	35	57	96	60

Farms in the study sold an average of 9,107 pounds of milk per cow, Table 2. There was little difference in sales per cow between the two larger size groups. Sales per cow from these herds exceeded the small herd average by more than 1200 pounds.^{2/}

^{2/} Data only on milk sold to plants and dealers were obtained for this study. Total production per cow exceeded the amount reported here by the amount of milk consumed on the farm or otherwise not entering commercial channels.

Table 2. Selected characteristics per cow, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	Unit	Number of cows			All farms
		45 or less	46-65	66 or more	
Milk sales	lbs.	8072	9307	9360	9107
Cropland ^{1/}	Acres	2.16	2.24	2.16	2.20
Permanent pasture	Acres	2.53	2.59	1.80	2.28
Total acres ^{2/}	Acres	4.70	4.83	3.96	4.48

^{1/} Land used for harvested feedcrops and temporary grazing crops.

^{2/} Average total acres used per cow.

The land resource used for the dairy enterprise on the farm included owned, rented, and leased land, and was divided into two categories; cropland and pasture.

On the average, the dairy enterprise required about 4.5 acres of land per cow, Table 2. Of these land requirements, 2.2 acres were cropland and 2.3 acres were permanent pasture. Cropland requirements were about the same for each of the three size groups. The amount of permanent pasture available per cow did not differ very much between the small and medium herd size categories. However, farms with more than 65 cows averaged using only 1.8 acres of permanent pasture per cow or about three-fourths of an acre less than that used in the smaller operations. This difference was primarily a reflection of the effect of the largest farm in the study which was a dry lot operation with very little permanent pasture.

Capital Investment

Capital investment^{3/} associated with the dairy enterprise was divided into four categories: (1) land, buildings, and improvements, (2) machinery and equipment, (3) feed, seed and supplies, and (4) dairy livestock. Total investment per cow averaged \$1,336.65 for all farms studied, Table 3. Farms in the medium herd size category had the lowest total investment per cow, \$1,277.81, while the farms with the large herds had the highest investment per cow, \$1,402.94. Investment in land buildings, and improvements accounted for the major portion of the total investment (54-56 percent) regardless of the size of the herd. Next in importance was the investment in dairy livestock, averaging \$342.36 per cow on all farms - slightly more than one-fourth of the total investment. Investment in machinery and equipment tended to decline as the number of cows in the herd increased, ranging from \$237.11 per cow on farms with small herds to \$193.36 per cow on those farms with large herds. For all farms, investment in

^{3/} The average of the beginning and end of the year value.

machinery and equipment averaged \$208.44 per cow--about one-sixth of the total investment. The remaining four percent of the total investment was accounted for by feed, seed and supplies inventories.

Table 3. Average investment per cow, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	Number of cows			All
	45 or less	46-65	66 or more	farms
(dollars)				
Land, buildings & improvements	724.91	711.39	751.63	728.48
Dairy livestock	334.26	311.53	383.45	342.36
Machinery & equipment	237.11	209.99	193.36	208.44
Feed, seed & supplies	<u>52.65</u>	<u>44.90</u>	<u>74.50</u>	<u>57.35</u>
Total investment	1,348.93	1,277.81	1,402.94	1,336.63
Percent of total				
Land, buildings & improvements	54.80	55.67	53.57	54.50
Dairy livestock	24.80	24.39	27.34	25.61
Machinery & equipment	17.50	16.43	13.78	15.16
Feed, seed & supplies	<u>3.90</u>	<u>3.51</u>	<u>5.31</u>	<u>4.29</u>
Total	100.00	100.00	100.00	100.00

CHAPTER III

COSTS AND RETURNS

Traditionally, two measures have been used to evaluate the costs and returns to dairy enterprises: (1) average per cow, and (2) average per hundredweight of milk. For purposes of this analysis, expenses and receipts per hundredweight of milk sold and per cow were calculated from the gross accounting data reported by the farmers. These averages per hundredweight of milk sold for the three herd-size groupings and for all farms studied are reported below. Averages per farm and per cow are reported in Appendix B.

Cost

The farm expenses associated with the dairy enterprise were divided into twelve accounts: ten cash cost and two non-cash cost accounts. Total cash costs per hundred pounds of milk sold ranged from \$4.39 in the small dairies to \$5.26 in the larger dairies and averaged \$4.80 for all farms studied, Table 4. Purchased feed was the major cost item for all farms, regardless of herd size. Purchased feed costs averaged \$2.04 and accounted for almost 35 percent of total cost for all farms studied. Next in importance was fertilizer, seed, lime and chemicals averaging 58 cents per hundredweight on all farms and accounting for about 10 percent of the total.

Depreciation on the average accounted for only 10 percent of the total cost per hundredweight of milk sold. On the 30 farms depreciation averaged 50 cents or slightly more per hundredweight of milk sold.

The total cost per hundredweight of milk sold, exclusive of a charge for unpaid operator and family labor, average \$5.32 for all farms, Table 4. Farms in the smallest herd-size group had the lowest cost--an average of \$4.92 per hundredweight--although only 11 cents lower than the cost for the medium herd size group. Total cost for farms with the largest herds averaged \$5.76 per hundredweight of milk sold--84 cents greater than the cost for the smallest herds.

Even though, in general, total cost per hundredweight of milk increased as the number of cows in the milking herd increased, all of the various cost items did not follow the same trend. For example, the cost of hauling and custom hire declined as size of herd increased. One plausible explanation for this decline is that as farms become larger, less reliance is placed on custom hiring of machinery and equipment as more equipment is farm owned. Such would appear to have been the case for the farms studied as evidenced by the increase in fuel, machinery and equipment costs. Average equipment costs for the larger herd sizes would likely have been higher had not one farm followed the practice of leasing all of the tractors and silage equipment used. As an accounting convenience, these charges were included in the miscellaneous farm expenses. To some extent, the inclusion of these lease charges contributed to the higher cost per hundredweight for this account for the largest herd size.

Greater requirements for hired labor and decreasing use of concentrates produced on their own farm as herd size increased were reflected by the costs for these items. The cost of hired labor per hundredweight of milk sold on the largest farms averaged twice that for the small farms. Proportionately, the increase in the cost for purchased feeds as herd size increased was not as great--\$1.94 as compared to \$2.10.

Table 4. Average cost per hundredweight of milk sold, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	Number of cows				All farms
	: 45 or less	: 46-65	: 66 or more		
	(dollars)				
Cash cost					
Purchased feed ^{1/}	1.94	2.01	2.10		2.04
Fert., seed, lime & chemicals	.60	.54	.58		.58
Hired labor	.33	.49	.66		.53
Dairy supplies & services ^{2/}	.25	.34	.39		.34
Hauling and custom hire	.35	.27	.25		.28
Interest expense	.28	.16	.36		.26
Miscellaneous expenses ^{3/}	.17	.19	.39		.27
Machinery & equipment ^{4/}	.21	.24	.27		.24
Fuel	.14	.15	.16		.15
Insurance and taxes	.11	.12	.10		.11
Total cash cost	4.39	4.51	5.26		4.80
Depreciation ^{5/}	.53	.52	.50		.52
Total cost	4.92	5.03	5.76		5.32

^{1/} Includes all feed purchased for the milking herd and replacements.

^{2/} Veterinarian fees, breeding fees, dairy supplies and general farm supplies.

^{3/} Utilities, real estate improvements, leases and rent.

^{4/} Repair and maintenance of all machinery and equipment associated with the dairy enterprise.

^{5/} Does not include depreciation on livestock.

Income

The total income per hundred pounds of milk sold came from three sources (1) sales of milk, (2) sales of surplus livestock and (3) increases in inventories.^{5/} Sales of milk accounted for

^{5/} Increases in dairy livestock and feed, seed and supplies inventories. Since total cost includes the cost of producing and acquiring all items of the dairy livestock and feed, seed, and supplies inventories, increases in the value of these inventories must be counted as income.

almost 87 percent of the total for all farms, Table. 5. Differences in value of milk sold per hundredweight were likely due to (1) differences in the butterfat content of the milk sold, (2) differences in Class I and Class II prices, and (3) differences in the proportion of the milk utilized as Class I.

Table 5. Average gross receipts per hundredweight of milk sold, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	Number of cows			All farms
	: 45 or less	: 46-65	: 66 or more	
(dollars)				
Cash income				
Milk sales	5.81	6.05	5.64	5.86
Sale of surplus livestock	<u>.25</u>	<u>.58</u>	<u>.52</u>	<u>.50</u>
Total cash income	6.06	6.63	6.16	6.36
Inventory increases	<u>.75</u>	<u>.23</u>	<u>.50</u>	<u>.41</u>
Total income	6.81	6.86	6.66	6.77

The sale of surplus livestock was the second most important source of income, amounting to about 50 cents per hundredweight of milk sold. Increases in inventories averaged 41 cents per hundredweight, 6 percent of the total.

Gross income per hundredweight of milk sold was \$6.77 for all farms. There was little difference in gross income per hundredweight of milk sold among farm sizes even though there was considerable variation among the various sources of income. The range in total income was from a high of \$6.86 per hundredweight on farms in the 46-65 cow herd-size category to a low of \$6.66 for farms in the 65 or more cow size category.

Net Returns per Hundredweight of Milk Sold

The difference between the gross income per hundredweight of milk sold and the total cost represents a return to the unpaid family and operator labor and management and to their investment in the dairy enterprise. These net returns averaged \$1.45 per hundredweight for the farms studied, Table 6. For farms with 65 or fewer cows, net returns were more than twice as high as for farms with 66 or more cows--\$1.89, \$1.83 and \$.90 for the small, medium and large groups, respectively.

In certain instances, the earnings accruing to the farm operator and his family for their labor on the dairy enterprise may be of interest. In order to arrive at some estimate of the residual return to the family and operator labor and management (or the return above all expenses including interest or investment) an interest charge of five percent was made for the farmers' average equity^{6/}

^{6/} Equity was defined as the difference between total assets and total liabilities for the dairy enterprise, i.e., net worth for the dairy enterprise.

in the dairy enterprise. Deducting this charge left an average net return to unpaid family and operator labor and management of 92 cents per hundredweight of milk sold for all of the farms studied, Table 6. Returns to family and operator labor and management on farms with more than 65 cows averaged only 38 cents per hundredweight, or 91-92 cents less than those for smaller operators.

Table 6. Average net returns per hundredweight of milk sold, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	Number of cows			
	:45 or less	46-65	:66 or more	: All farms
	(dollars)			
Total Income	6.81	6.86	6.66	6.77
Less total cost	4.92	5.03	5.76	5.32
Net returns to unpaid labor, management and capital	1.89	1.83	.90	1.45
Less interest on average equity @ 5%	.59	.52	.52	.53
Net returns to unpaid family and operator labor and management	1.30	1.31	.38	.92

The substantially lower average net returns per hundredweight for the larger herds may have occurred for any of several reasons. For one, more hired labor relative to unpaid operator and family labor was used on farms with large herds. Since the cost of hired labor was included in the cash expenses, the residual return per hundredweight to labor was reduced to this extent. In addition, there appeared to have been a tendency for the large farms to substitute machinery and equipment for labor, thus reducing the residual returns to unpaid operator and family labor.

Variability of Net Returns per Hundredweight

Net returns to operator and unpaid family labor were quite variable among farms. Five of the 30 farms had net losses while three showed net returns of more than \$2.00 per hundredweight, Table 7. Almost one-half of the farms (14 of the 30) had net returns between \$0.50 and \$1.50 per hundredweight of milk sold.

Table 7. Distribution of farms by average net returns per hundredweight of milk sold, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Net returns (dollars)	Number of cows			
	:45 or less	46-65	:66 or more	: All farms
	(number of farms)			
Less than -\$0.50	1	0	2	3
-.049 - 0.00	0	1	1	2
0.01 - 0.50	0	1	1	2
0.51 - 1.00	1	5	1	7
1.01 - 1.50	3	3	1	7
1.51 - 2.00	3	2	1	6
2.01 or more	1	2	0	3

Net Returns per Farm

Even though net returns to operator and family labor per hundredweight of milk sold averaged considerable less for the farms with large herds than those with the small herds, total net returns from the dairy enterprise were only \$545 less for the farms with large herds, Table 8. Net returns from the dairy enterprise for the farms with 46-65 cows averaged slightly over \$6,900 while the average for all farms was almost \$5,000.

Even though the net returns to operator and family labor from the dairy enterprise were lowest on the large farms, returns from all enterprises were the highest, averaging almost \$8,400 per farm, Table 8. Data that would permit comparisons of net returns per hour of operator and unpaid family labor used for the dairy enterprise were not available. However, one would suspect that per hour returns among size groups would compare more favorably than did total returns. Farms with the largest herds averaged receiving only 38 percent of their total net returns from the dairy enterprise; whereas the small and medium herd-size farms received more than 80 percent of their total net returns from that source.

Table 8. Comparison of average net returns to unpaid operator and family labor, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Net returns	Number of cows			All farms
	: 45 or less:	46-65 :	66 or more:	
	(dollars)			
Per hundredweight of milk	1.30	1.31	.38	.82
Total per farm from the dairy enterprise	3,731.55	6,509.76	3,186.13	4,990.53
Total per farm from all enterprises	4,559.39	7,833.35	8,383.14	6,979.43

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Appendix A, Table 1. Selected characteristics, averages per farm, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	Unit	Number of cows			All farms
		:45 or less	:46-65	:66 or more	
Labor ^{1/}	Man yrs.	1.32	2.18	3.18	2.15
Milk sales	Lbs.	284,302	531,144	894,578	541,578
Crop land ^{2/}	Acres	76.20	127.80	206.70	130.90
Permanent pasture	Acres	89.20	147.80	137.70	135.90
Total acres ^{3/}	Acres	165.40	275.60	344.40	266.80
Other enterprises ^{4/}	Acres	137.10	39.30	439.70	165.40
Total all enterprises	Acres	302.50	314.90	784.10	432.20

^{1/} Manager, unpaid labor and hired labor.

^{2/} Harvested feed crops and temporary grazing crops.

^{3/} Total acres utilized by the dairy operation.

^{4/} Enterprises other than dairy related enterprises.

Appendix A, Table 2. Average investment in the dairy enterprise per farm, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	Number of cows			All farms
	:45 or less	:46-65	:66 or more	
	(dollars)			
Land, buildings & improvements	25,516.88	40,549.64	71,855.85	43,344.66
Dairy livestock	11,766.00	17,757.00	36,658.28	20,370.03
Machinery & equip.	8,346.11	11,969.36	18,485.43	12,402.86
Feed, seed & supplies	1,853.11	2,559.35	7,122.28	3,412.20
Total	47,482.10	72,835.35	134,121.84	79,529.75

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Appendix B, Table 1. Production costs per farm, by herd size,
30 Grade "A" dairy farms, Mississippi, 1966.

	Number of cows			
Item	:45 or less	: 46-65	:66 or more	: All farms
	(dollars)			
Cash costs				
Purchased feed ^{1/}	5,514.77	10,694.28	18,793.28	11,030.40
Fertilizer, seed, lime & chemicals	1,712.44	2,884.93	5,182.85	3,165.53
Hired labor	954.66	2,595.71	5,953.14	2,886.80
Dairy supplies & services ^{2/}	712.44	1,799.73	3,488.71	1,867.46
Hauling & custom hire	1,004.00	1,447.93	2,261.00	1,504.43
Interest expense	808.11	866.93	3,262.29	1,408.20
Miscellaneous farm expenses ^{3/}	473.11	1,027.00	3,517.71	1,442.33
Machinery & equipment ^{4/}	583.56	1,237.36	2,473.36	1,329.46
Fuel	391.11	790.07	1,435.43	820.99
Insurance & taxes	309.77	626.21	887.43	592.26
Total cash cost	12,463.97	23,970.15	47,255.20	26,047.86
Depreciation ^{5/}	1,497.77	2,774.30	4,441.66	2,780.40
Total cost	13,961.74	26,744.45	51,696.86	28,828.26

^{1/} Includes all feed purchased for the milking herd and replacements.

^{2/} Veterinarian fees, breeding fees, dairy supplies and general farm supplies.

^{3/} Utilities, real estate improvements, leases and rent.

^{4/} Repair and maintenance of all machinery and equipment associated with the dairy enterprise.

^{5/} Does not include depreciation on livestock.

Appendix B, Table 2. Costs per cow, by herd size, 30 Grade
"A" dairy farms, Mississippi, 1966.

Item	Number of cows			
	: 45 or less:	46-65 :	66 or more:	All farms
	(dollars)			
Cash cost				
Purchased feed ^{1/}	156.65	187.61	196.58	185.04
Fertilizer, seed, lime & chemicals	48.65	50.61	54.22	53.21
Hired labor	27.11	45.54	62.27	48.52
Dairy supplies & services ^{2/}	20.24	31.57	36.50	31.39
Hauling & custom hire	28.53	25.40	23.65	25.34
Interest expense	22.96	15.21	34.12	23.60
Miscellaneous farm expenses ^{3/}	13.45	18.02	36.80	24.24
Machinery & equipment ^{4/}	16.54	21.70	25.87	22.34
Fuel	11.12	13.86	15.01	13.80
Insurance & taxes	<u>8.78</u>	<u>10.97</u>	<u>9.28</u>	<u>9.94</u>
Total cash cost	354.06	420.49	494.30	437.42
Depreciation ^{5/}	<u>42.55</u>	<u>48.67</u>	<u>46.46</u>	<u>46.72</u>
Total cost	396.61	469.16	540.76	484.14

- ^{1/} Includes all purchased feed for the milking herd and replacements.
- ^{2/} Veterinarian fees, breeding fees, dairy supplies and general farm supplies.
- ^{3/} Utilities, real estate improvements, leases and rent.
- ^{4/} Repair and maintenance of all machinery and equipment associated with the dairy enterprise.
- ^{5/} Does not include depreciation on livestock.

Appendix B, Table 3. Dairy income per farm, by herd size, 30
Grade "A" dairy farms, Mississippi, 1966.

Item	Number of cows			
	:45 or less:	46-65	:66 or more:	All farms
	(dollars)			
Cash income				
Milk sales	16,524.55	32,115.14	50,447.20	31,715.52
Surplus livestock	<u>702.77</u>	<u>3,087.28</u>	<u>4,603.00</u>	<u>2,725.60</u>
Total cash income	17,227.32	35,202.42	55,050.20	34,441.12
Increases in inventories ^{1/}	<u>2,128.88</u>	<u>1,205.29</u>	<u>4,440.57</u>	<u>2,237.33</u>
Total income	19,356.20	36,407.71	59,490.77	36,678.45

^{1/} Increases in dairy livestock inventories and feed, seed,
and supplies inventories.

Appendix B, Table 4. Gross income per cow, by herd size, 30
Grade "A" dairy farms, Mississippi, 1966.

Item	Number of cows			
	:45 or less:	46-65	:66 or more:	All farms
	(dollars)			
Cash income				
Milk sales	469.43	563.42	527.69	533.03
Sale of surplus livestock	<u>19.97</u>	<u>54.16</u>	<u>48.15</u>	<u>45.82</u>
Total cash income	480.40	617.58	575.84	578.85
Increase in inventories ^{1/}	<u>60.48</u>	<u>21.14</u>	<u>46.45</u>	<u>37.60</u>
Total income	549.88	638.72	622.29	616.45

^{1/} Increases in dairy livestock inventories and feed, seed,
and supplies inventories.

Appendix B, Table 5. Average net returns to the dairy enterprise per farms, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	: Number of cows :			
	:45 or less:	46-65	:66 or more :	All farms
	(dollars)			
Receipts	19,356.20	36,407.71	59,490.77	36,678.46
Less: Cash expenses	12,463.53	23,970.15	47,254.98	26,047.86
Depreciation	1,497.77	2,774.30	4,441.66	2,780.40
Interest on equity @ 5 percent	<u>1,663.35</u>	<u>2,753.50</u>	<u>4,608.00</u>	<u>2,859.65</u>
Returns to operator and family labor	3,731.55	6,909.76	3,186.13	4,990.55

Appendix B, Table 6. Returns per cow from the dairy enterprise, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	: Number of cows :			
	:45 or less:	46-65	:66 or more :	All farms
	(dollars)			
Receipts	549.88	638.62	622.29	616.45
Less: Cash expenses	354.06	420.49	494.30	437.42
Depreciation	42.55	48.67	46.46	46.22
Interest on equity @ 5 percent	<u>47.25</u>	<u>48.31</u>	<u>48.20</u>	<u>48.07</u>
Returns to operator and family labor	106.02	121.15	33.33	84.74

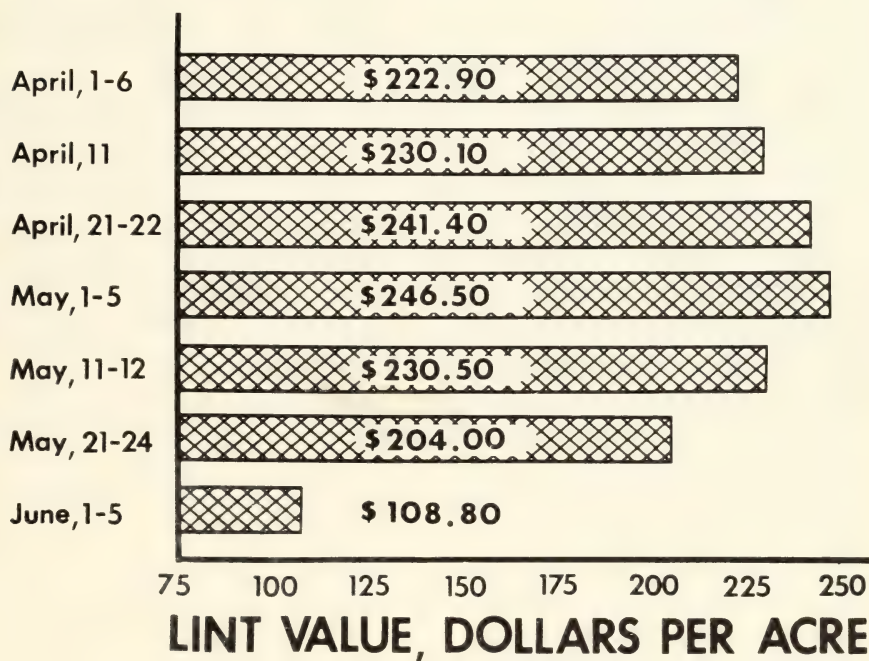
Appendix B, Table 7. Net returns from all enterprises, by herd size, 30 Grade "A" dairy farms, Mississippi, 1966.

Item	Number of cows			
	:45 or less:	46-65	:66 or more	: All farms
	(dollars)			
Total farm income	22,442.60	38,328.71	75,176.57	42,157.40
Less: Cash expenses	13,846.85	24,333.70	55,716.57	28,743.55
Depreciation	1,849.61	3,141.21	5,351.43	3,269.45
Interest on equity @ 5 percent	<u>2,186.75</u>	<u>3,020.25</u>	<u>5,725.43</u>	<u>3,424.73</u>
Returns to operator and family labor	4,559.39	7,833.55	8,383.14	6,719.67



Studies On Planting Dates Of Cotton And Effects Of Three Chemical Treatments

PLANTING DATE



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STUDIES ON PLANTING DATES OF COTTON AND EFFECT OF THREE CHEMICAL TREATMENTS

C. D. RANNEY¹

The cotton farmer takes a calculated risk at planting time. The decision as to when to plant can greatly influence final production costs and yield. A poor stand of plants often results in increased production costs and in reduced production efficiency yield and quality. Planting under ideal conditions would maximize yields and minimize the risk of losing a stand.

The following is from studies reported in 1934 (1): "In the central part of the Mississippi Delta cotton was planted at 5 - day intervals, from March 25 to the middle of May, for a series of years. The best time was found to be between April 10 and 20, with little difference in yields secured from plantings made at different times between these dates."

A similar study was completed in 1939 (2,3,4), during a period of transition from animal to tractor power. Results indicate optimum yields were obtained with April 15 and May 1 plantings (Table 1). With more complete mechanization it is now possible to plant allotted cotton acreage in a shorter period of time. Fungicides that reduce seedling disease losses have been developed and are recommended for use at planting time (7).

In 1960 we sought to determine the optimum planting date for the use of modern agronomic practices and mechanized methods, and also to evaluate the effect of three chemical treatments on stands and yields.

Methods and Materials

Planting dates of April 1, April 11, April 21, May 1, May 11, May 21 and June 1 were chosen. Each year planting was made on these dates or as soon thereafter as conditions permitted.

We used the variety M-8, a doubled haploid of Deltapine 14. All seeds were produced in 1959. With favorable storage, a germination record of 86 percent was maintained throughout the study. All seed were treated with 7.7% N-(ethyl-mercuri) - p - toluenesulfonanilide (cercosan M) at the rate of 3 oz/cwt. In addition to this basic treatment two other treatments were used. Reagent grade calcium sulfate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) was applied to the seed at the rate of 4 lbs/cwt. At planting time, a dust containing 10% N-(trichloromethylthio) - 4 - cyclohexent-1,2, dicarboximide (captan) and 10% pentachloronitrobenzene (PCNB) was mixed with the seed (planter - box treatment) at the rate of 15 lbs/cwt.

Seed were planted with a Stoneville drum planter on Bosket silt loam. Ninety pounds of nitrogen per acre was added as anhydrous ammonia. The seed were hilldropped on 20 - inch centers in 40-inch rows. Seeding rate was 20 lbs. of machine - delinted seed per acre.

Test design was a randomized split-plot with six replications. Main plots were planting dates and subplots were chemical treatments. Subplot size was two rows 65 feet long. There were two border rows on each side of the main plots to minimize border effect.

All plots received a preemergence application of 3-(3,4 - dichlorophenyl) - 1, -1-dimethylurea (diuron) at a broadcast rate of 0.65 lbs/A although only a 14-inch band was treated. On plots planted in May and June herbicidal oil or 1,1' - di-

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methyl - 4,4' - bipridinium salt (paraquat) had been used to control preplanting weed growth. An intensive insecticide program, including late - season applications, was maintained. April plantings were partially hand - harvested to reduce field loss; final harvest was made with a spindle - type mechanical picker.

Results

Table 2 summarizes the effect of planting date on stand, and also stand uniformity of stand as measured by surviving hills per acre and yield. Planting on May 1-5 gave maximum stands, the highest uniformity of stand and maximum yields. Early April plantings or plantings after May 12 resulted in significantly lower stands and yields.

The effect of chemical treatment on stand, stand uniformity and yield are summarized in Table 3. The use of planter - box treatment resulted in significantly better stands that yielded more seed cotton than the other seed treatments. Seed treatment with calcium sulfate at 4 lbs/cwt resulted in significantly reduced stands and yields.

Table 4 shows the effect of the different cropping seasons on stand, stand uniformity and yield. A progressive reduction in stand occurred each year that the test was conducted. This stand reduction was due to higher incidence of seedling disease; maximum disease severity occurred in 1964. An increase in disease severity is characteristic of continuous cotton culture. Prior to the start of this study corn was grown in the test field for one year.

Analysis of test data indicate a significant interaction between planting dates and chemical treatment. In Table 5 the averages of stand, stand uniformity and yield are summarized by planting date and chemical treatment. In only one instance was there a significant difference between the Ceresan M and Ceresan M + calcium sulfate treatments.

In contrast to this similarity in response are the differences between the Ceresan M and Ceresan M + 10% captan and 10% PCNB treatments. In the April plantings, stand, stand uniformity and yield were significantly increased by the planter - box fungicide treatment. In later plantings, however, there was no increase and in some cases there was a reduction as compared to Ceresan M treatment (Table 6).

While there are variations between years, there are consistent stand improvements at the early planting dates. The average improvement was 21% for April 1 - 5 plantings, 25% for April 11 plantings and nearly 20% for the April 21 - 22 plantings. In plantings after May 1-5, only slight stand improvements or in many instances stand reductions resulted from this planter - box fungicide treatment. Yield data indicate a similar pattern of performance (Table 5).

In Table 7 the yield differences between the Ceresan M and the Ceresan M + 10% captan and 10% PCNB treatments are expressed in dollars per acre. There is a high return from using the planter - box treatment in the early plantings. After May 11 - 12, however, this treatment resulted in reduced yield and crop value as compared to the Ceresan M treatment. The results attributable to the planter - box fungicide treatment are the major factor responsible for the planting date x chemical treatment interaction.

Our summaries of stand, stand uniformity, and yield for each crop year are presented in tabular form in the appendix of this bulletin.

Discussion

Maximum stands, stand uniformity and yield were obtained with plantings made on May 1-5 during this 5-year study. Earlier plantings resulted in poorer stands and lower yields. With late May plantings yields were reduced although better stands were obtained.

Studies reported in the 1960 to 1965 Annual Progress Reports of the Northeast Louisiana Agricultural Experiment Station with planting dates of mid-April, early May and mid-May, indicate maximum yields resulted from early May plantings. Work in Arkansas, reported by Waddle (9), indicate that the first week in May is the most desirable planting time.

These results closely parallel the probability of having a 10-day period of 68° F soil temperatures following planting (8). The probability of chilling damage is less than 25 percent for the following areas and dates: South Delta April 21; Central Delta, April 24; and for the North Delta, April 27. Therefore, the goal of May 1 planting date would lower the probability of having adverse weather and still permit maximum production.

The use of a planter - box application of a fungicide resulted in increased stands and uniformity with increased yields. Considering treatment costs of \$0.75 per acre, the benefit obtained from this practice (Table 7) certainly justifies its use.

During 1960 - 1964, we conducted 38 other tests using the planter - box fungicide treatment at various locations and planting dates in the Mississippi Delta.

The average benefit from the use of a planter - box fungicide in the tests indicate a gain of 6,000 plants per acre and a yield increase of 172 lbs. of seed cotton. At the value of 10 cents per 1 lb. for seed cotton, this would mean a \$17-

.20 return for a \$0.75 investment in a planter - box fungicide.

A number of reports (5,6,10) indicate that the use of a calcium salt as a seed or soil treatment is beneficial. In the studies reported here, a significant decrease in stand and yield was associated with the use of a calcium salt at 4 lbs/cwt of cottonseed. Maximum depression from this treatment on stand and yield was noted in plantings on April 21-22 and earlier.

Conclusions

This study indicates that ideal planting procedures would be as follows:

1. Use of high quality seed, with minimum germination of 80 percent of the desired variety treated with a recommended seed fungicide.

2. Plan farm operations to permit planting on April 21 or as soon thereafter as possible.

3. If planting is started before May 1, a soil fungicide treatment, either a planter - box application or other recommended method, should be applied during the planting process.

4. If planting is started after May 1, a supplemental fungicide should not be used.

Acknowledgement

Mr. J. B. Dick, retired Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Stoneville, Mississippi deserves thanks for his assistance.

Table 1. Summary of yield data from date of planting studies at Stoneville, Mississippi 1929 to 1939.

Date of planting	Acre yield in pounds of seed cotton	
	9-year average 1929-1939 excluding 1934 and 1935 <u>1/</u>	11-year average 1929-1939
April 1	1610.9	1317.9
April 15	1815.7	1675.0
May 1	1504.9	1546.4
May 15	1318.0	1317.7
June 1	881.0	864.1
June 15	290.8	312.1

1/ In 1934 April 1 and April 15 plantings were killed. In 1935 April 1 planting was killed.

Table 2. Effect of planting date on stand, stand uniformity and yield. Average of 5 years, 1960 to 1964.

Planting date	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
April 1-6	21,312 e	5,624 e	2,229 bc
April 11	23,600 e	5,908 d	2,301 ab
April 21-22	30,818 cd	6,256 c	2,414 ab
May 1-5	38,566 a	7,092 a	2,465 a
May 11-12	33,897 b	6,897 a	2,305 ab
May 21-24	30,173 d	6,468 bc	2,040 c
June 1-5	33,085 bc	6,586 b	1,088 d

1/ Means followed by the same letter are not significantly different at the .01 level as measured by Duncan's New Multiple Range Test.

PLANTING DATES AND CHEMICAL TREATMENTS

Table 3. Effect of chemical treatment on stand, stand uniformity and yield. Average of 5 years, 1960 to 1964.

Chemical treatment	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
Ceresan M	29,701 b	6,257 b	2,113 b
Ceresan M + CaSO ₄	28,099 c	6,151 b	2,054 c
Ceresan M + captan & PCNB	32,823 a	6,806 a	2,194 a

1/ Means followed by the same letter are not significantly different at the .01 level as measured by Duncan's New Multiple Range Test.

Table 4. Effect of planting season with 7 plantings from April 1 to June 1, on stand, stand uniformity and yield. 1960 through 1964.

Year	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
1960	37,153 a	7,094 a	1,598 d
1961	33,091 b	6,789 a	1,977 c
1962	32,243 b	6,344 b	2,520 a
1963	26,931 c	6,205 b	2,277 b
1964	21,619 d	5,590 c	2,230 b

1/ Means followed by the same letter are not significantly different at the .01 level as measured by Duncan's New Multiple Range Test.

Table 5. Effect of three chemical treatments at different planting dates on stand, stand uniformity and yield. Average of 5 years, 1960 to 1964.

Planting date	Chemical treatment	1/ Plants per acre	2/ per acre	Hills per acre	2/ per acre	Yield, lbs. of seed cotton	2/ per acre
April 1-6	St	18,968	b	5,308	b	2,203	a
	St + Ca	19,860	b	5,311	b	2,188	a
	St + pbt	25,107	a	6,254	a	2,298	a
April 11	St	22,362	b	5,464	b	2,183	b
	St + Ca	20,497	b	5,586	b	2,242	b
	St + pbt	27,943	a	6,676	a	2,477	a
April 21-22	St	29,797	b	5,995	b	2,301	b
	St + Ca	27,699	b	5,914	b	2,280	b
	St + pbt	34,987	a	6,860	a	2,662	a
May 1-5	St	39,170	ab	7,138	ab	2,464	a
	St + Ca	36,493	bc	6,868	b	2,421	a
	St + pbt	40,036	a	7,272	a	2,510	a
May 11-12	St	33,424	a	6,844	ab	2,350	a
	St + Ca	32,135	a	6,660	b	2,221	a
	St + pbt	36,133	a	7,189	a	2,343	a
May 21-24	St	30,145	ab	6,541	a	2,143	a
	St + Ca	28,245	b	6,306	a	1,979	b
	St + pbt	31,952	a	6,557	a	1,999	b
June 1-5	St	34,038	a	6,516	ab	1,148	a
	St + Ca	31,611	a	6,412	b	1,048	a
	St + pbt	33,064	a	6,831	a	1,070	a

1/ St = 3 oz/cwt Ceresan M
 St + Ca = 3 oz/cwt Ceresan M + 4 lbs/cwt of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
 St + pbt = 3 oz/cwt Ceresan M + 15 lbs/cwt of 10% captan and 10% PCNB

2/ Means, within planting dates, followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Table 6. Percent difference in stand obtained from using a planter-box fungicide treatment at planting. Average of 5 years, 1960 to 1964.

Planting date	Year 1/					Average
	1960	1961	1962	1963	1964	
April 1-6	11.98	55.22	36.03	- 3.18	6.98	21.41
April 11	7.59	52.23	27.29	15.09	19.49	24.34
April 21-22	2.23	4.63	5.86	35.72	50.13	19.71
May 1-5	5.52	9.17	- 4.20	3.59	- 3.39	2.14
May 11-12	6.40	8.35	- 0.39	7.48	3.75	5.12
May 21-24	- 1.69	4.51	0.00	- 1.52	- 0.79	0.10
June 1-5	0.64	5.80	- 8.18	14.70	16.36	5.86
Average	4.67	19.99	8.06	10.27	13.22	11.24

1/ Minus sign denotes instances where the use of a planter-box fungicide resulted in stand reductions.

Table 7. Dollar value of using a planter-box fungicide treatment at planting. Based on seed cotton value of 10¢ per pound.

Planting date	Year 1/					Average ^{1/}
	1960	1961	1962	1963	1964	
April 1-6	8.10	32.20	24.40	-28.30	10.50	9.38
April 11	11.20	38.30	17.40	36.50	43.10	29.30
April 21-22	2.40	16.30	- 5.10	32.70	134.60	36.18
May 1-5	19.10	7.80	- 4.70	- 6.40	7.20	4.60
May 11-12	- 0.60	18.60	-16.30	-29.20	23.90	- .72
May 21-24	-23.20	- 4.70	-21.50	-42.10	19.40	-14.42
June 1-5	-13.10	- 5.20	- 2.10	-12.40	- 5.70	- 7.70
Average	0.56	14.76	- 1.13	- 7.03	33.29	8.09

1/ Minus sign denotes instances where the use of a planter-box fungicide resulted in loss.

APPENDIX

Appendix Table 1. Date of planting study, 1960. Effect of seed treatment with different chemicals at different planting dates.

Planting date	Treatment <u>1/</u>	Plants per acre <u>2/</u>	Hills per acre <u>2/</u>	Yield, lbs. of seed cotton <u>2/</u>
April 2	St	34,469	6,609	1,411
	St + Ca	29,898	6,028	1,270
	St + pbt	36,178	7,401	1,492
April 11	St	44,990	7,151	1,266
	St + Ca	37,547	7,236	1,258
	St + pbt	42,371	7,694	1,378
April 21	St	46,198	7,444	1,562
	St + Ca	40,708	7,276	1,547
	St + pbt	44,990	7,610	1,586
May 2	St	34,594	6,777	1,531
	St + Ca	37,507	6,819	1,552
	St + pbt	41,417	7,151	1,722
May 12	St	38,381	7,193	1,774
	St + Ca	39,085	7,069	1,637
	St + pbt	43,570	7,653	1,768
May 21	St	34,137	7,401	2,475
	St + Ca	34,969	7,485	2,402
	St + pbt	32,267	7,276	2,243
June 1	St	26,777	6,446	1,321
	St + Ca	31,935	6,778	1,172
	St + pbt	27,235	6,487	1,190

1/ St = 3 oz/cwt Ceresan M.

St + Ca = 3 oz/cwt Ceresan M + 4 lbs/cwt of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

St + pbt = 3 oz/cwt Ceresan M + 15 lbs/cwt of 10% captan and 10% PCNB.

1/ Differences within planting dates are not significant.

Appendix Table 2. Date of planting study, 1960. Effect of planting date.

Planting date	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
April 2	33,515 c	6,679 bc	1,391 b
April 11	41,636 ab	7,361 a	1,301 b
April 21	43,965 a	7,443 a	1,565 b
May 2	37,840 bc	6,915 abc	1,602 b
May 12	40,681 ab	7,305 ab	1,726 b
May 21	33,791 c	7,387 a	2,373 a
June 1	28,649 d	6,571 c	1,228 b

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 3. Date of planting study, 1960. Effect of chemical treatment.

Treatment	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
Ceresan M	37,078 a	7,003 b	1,620 a
Ceresan M + CaSO ₄	35,949 a	6,956 b	1,548 a
Ceresan M + captan & PCNB	38,433 a	7,324 a	1,626 a

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 4. Date of planting study, 1961. Effect of seed treatment with different chemicals at different planting dates.

Planting date	Treatment <u>1/</u>	Plants per acre <u>2/</u>	Hills per acre <u>2/</u>	Yield, lbs. of seed cotton <u>2/</u>
April 6	St	14,844 c	4,741 c	2,158 b
	St + Ca	24,825 b	6,443 b	2,490 a
	St + pbt	34,222 a	7,359 a	2,480 a
April 11	St	16,178 b	4,616 b	2,200 b
	St + Ca	18,752 b	5,116 b	2,191 b
	St + pbt	29,357 a	7,027 a	2,583 a
April 21	St	40,542 ab	7,112 a	2,344 b
	St + Ca	37,675 b	6,941 a	2,392 b
	St + pbt	43,909 a	7,442 a	2,507 a
May 2	St	33,473 ab	6,819 ab	1,952 a
	St + Ca	29,936 b	6,279 b	2,044 a
	St + pbt	39,005 a	7,444 a	2,030 a
May 11	St	28,693 a	6,985 a	1,901 a
	St + Ca	28,609 a	6,154 b	1,959 a
	St + pbt	34,347 a	7,568 a	2,087 a
May 24	St	37,048 ab	7,402 a	1,863 a
	St + Ca	34,719 b	7,235 a	1,652 a
	St + pbt	42,828 a	7,736 a	1,816 a
June 2	St	41,455 ab	7,193 a	991 a
	St + Ca	39,337 b	7,359 a	934 a
	St + pbt	45,157 a	7,610 a	939 a

1/ St = 3 oz/cwt Ceresan M.

St + Ca = 3 oz/cwt Ceresan M + 4 lbs/cwt of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

St + pbt = 3 oz/cwt Ceresan M + 15 lbs/cwt of 10% captan and 10% PCNB.

2/ Differences within planting dates followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 5. Date of planting study, 1961. Effect of planting date.

Planting date	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
April 6	24,630 d	6,181 c	2,376 a
April 11	21,429 d	5,586 d	2,325 ab
April 21	40,709 ab	7,166 ab	2,414 a
May 2	34,139 c	6,848 b	2,009 bc
May 11	30,549 c	6,902 b	1,987 bc
May 24	38,199 b	7,457 a	1,777 c
June 2	41,983 a	7,387 a	954 d

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 6. Date of planting study, 1961. Effect of chemical treatment.

Treatment	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs of seed cotton <u>1/</u>
Ceresan M	30,319 b	6,410 b	1,915 b
Ceresan M + CaSO ₄	30,550 b	6,504 b	1,952 b
Ceresan M + captan & PCNB	38,403 a	7,455 a	2,063 a

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 7. Date of planting study, 1962. Effect of seed treatment with different chemicals at different planting dates.

Planting date	Treatment <u>1/</u>	Plants per acre <u>2/</u>	Hills per acre <u>2/</u>	Yield, lbs. of seed cotton <u>2/</u>
April 3	St	9,064 a	3,211 b	2,377 ab
	St + Ca	6,571 a	2,854 b	2,266 b
	St + pbt	10,729 a	4,368 a	2,621 a
April 11	St	15,633 a	4,368 b	2,399 a
	St + Ca	13,971 a	4,726 b	2,547 a
	St + pbt	18,046 a	5,560 a	2,573 a
April 21	St	38,587 a	7,104 a	2,608 a
	St + Ca	37,382 a	7,492 a	2,547 a
	St + pbt	37,589 a	7,520 a	2,557 a
May 5	St	51,727 a	7,789 a	2,932 a
	St + Ca	38,754 b	7,310 a	2,770 a
	St + pbt	37,549 b	7,462 a	2,885 a
May 11	St	42,707 a	7,193 a	3,088 a
	St + Ca	36,176 ab	7,312 a	3,124 a
	St + pbt	35,137 b	7,165 a	2,925 a
May 21	St	38,173 a	7,045 a	2,631 a
	St + Ca	27,982 b	5,707 b	2,210 b
	St + pbt	36,176 a	7,044 a	2,416 ab
June 5	St	60,127 a	7,669 a	1,773 a
	St + Ca	44,116 b	7,281 a	1,911 a
	St + pbt	40,916 b	7,042 a	1,752 a

1/ St = 3 oz/cwt Ceresan M.

St + Ca = 3 oz/cwt Ceresan M + 4 lbs/cwt of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

St + pbt = 3 oz/cwt Ceresan M + 15 lbs/cwt of 10% captan and 10% PCNB.

2/ Differences within planting dates followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 8. Date of planting study, 1962. Effect of planting date.

Planting date	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
April 3	8,788 c	3,478 d	2,421 b
April 11	15,884 d	4,885 c	2,507 b
April 21	37,853 bc	7,372 a	2,570 b
May 5	42,677 ab	7,521 a	2,863 ab
May 11	38,006 bc	7,223 a	3,046 a
May 21	34,110 c	6,598 b	2,418 b
June 5	48,387 a	7,331 a	1,812 c

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 9. Date of planting study, 1962. Effect of chemical treatment.

Treatment	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
Ceresan M	26,574 a	6,340 b	2,544 a
Ceresan M + CaSO ₄	29,279 b	6,097 c	2,482 a
Ceresan M + captan & PCNB	30,877 b	6,594 a	2,533 a

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range test.

Appendix Table 10. Date of planting study, 1963. Summary of effect of seed treatment with different chemicals at different planting dates.

Planting date	Treatment <u>1/</u>	Plants per acre <u>2/</u>	Hills per acre <u>2/</u>	Yield, lbs. of seed cotton <u>2/</u>
April 3	St	21,538 a	6,569 a	2,455 a
	St + Ca	23,869 a	6,569 a	2,438 a
	St + pbt	26,028 a	6,360 a	2,173 a
April 11	St	19,212 a	6,069 ab	2,713 a
	St + Ca	16,632 a	5,697 b	2,754 a
	St + pbt	27,235 a	6,985 a	3,078 a
April 22	St	17,381 a	5,238 b	2,955 a
	St + Ca	15,345 a	4,907 b	2,729 a
	St + pbt	36,714 a	7,109 a	3,282 a
May 1	St	38,922 a	6,984 a	3,310 a
	St + Ca	35,178 a	6,611 a	3,090 a
	St + pbt	45,615 a	7,235 a	3,246 a
May 11	St	26,528 a	6,152 a	2,181 a
	St + Ca	25,947 a	5,862 a	1,934 a
	St + pbt	32,305 a	6,612 a	1,889 a
May 21	St	25,399 a	5,656 a	1,809 a
	St + Ca	27,278 a	5,823 a	1,526 a
	St + pbt	32,599 a	5,570 a	1,388 a
June 3	St	22,290 a	5,945 ab	1,068 a
	St + Ca	20,998 a	5,530 b	850 a
	St + pbt	28,525 a	6,819 a	944 a

1/ St = 3 oz/cwt Ceresan M.

St + Ca = 3 oz/cwt Ceresan M + 4 lbs/cwt of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.

St + pbt = 3 oz/cwt Ceresan M + 15 lbs/cwt of 10% captan and 10% PCNB.

2/ Differences within planting dates followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 11. Date of planting study, 1963. Effect of planting date.

Planting date	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
April 3	23,812 b	6,500 ab	2,355 bc
April 11	21,026 b	6,250 abc	2,849 ab
April 22	23,147 b	5,751 bc	2,989 a
May 1	39,905 a	6,943 a	3,215 a
May 11	28,260 b	6,209 abc	2,001 cd
May 21	28,426 b	5,683 c	1,574 d
June 3	23,938 b	6,098 bc	954 e

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 12. Date of planting study, 1963. Effect of chemical treatment.

Treatment	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
Ceresan M	24,467 b	6,087 b	2,356 a
Ceresan M + CaSO ₄	23,607 b	5,857 b	2,189 a
Ceresan M + captan & PCNB	32,718 a	6,670 a	2,286 a

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 13. Date of planting study, 1964. Summary of effect of seed treatment with different chemicals at different planting dates.

Planting date	Treatment <u>1/</u>	Plants per acre <u>2/</u>	Hills per acre <u>2/</u>	Yield, lbs. of seed cotton <u>2/</u>
April 1	St	14,927 a	5,405 a	2,616 a
	St + Ca	14,137 a	4,658 a	2,477 a
	St + pbt	18,380 a	5,782 a	2,721 a
April 11	St	15,801 a	5,116 a	2,339 a
	St + Ca	15,583 a	5,156 a	2,460 a
	St + pbt	22,703 a	6,113 a	2,770 a
April 21	St	6,279 a	3,076 a	2,034 b
	St + Ca	7,236 a	2,953 a	2,180 b
	St + pbt	11,728 a	4,618 a	3,380 a
May 1	St	37,131 a	7,317 a	2,592 a
	St + Ca	41,083 a	7,319 a	2,649 a
	St + pbt	36,593 a	7,069 a	2,664 a
May 11	St	30,814 a	6,695 a	2,804 ab
	St + Ca	30,856 a	6,904 a	2,453 b
	St + pbt	34,305 a	6,946 a	3,043 a
May 21	St	15,967 a	5,199 a	1,937 a
	St + Ca	17,174 a	5,279 a	2,105 a
	St + pbt	15,885 a	5,158 a	2,131 a
June 1	St	19,544 a	5,324 a	585 a
	St + Ca	21,664 a	5,113 a	374 a
	St + pbt	26,196 a	6,195 a	528 a

1/ St = 3 oz/cwt Ceresan M.
 St + Ca = 3 oz/cwt Ceresan M + 4 lbs/cwt of $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$.
 St + pbt = 3 oz/cwt Ceresan M + 15 lbs/cwt of 10%
 captan and 10% PCNB.

2/ Differences within planting dates followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 14. Date of planting study, 1964. Effect of planting date.

Planting date	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
April 1	15,815 d	5,283 b	2,605 a
April 11	18,030 cd	5,462 b	2,523 a
April 21	8,414 e	3,549 c	2,531 a
May 1	38,269 a	7,235 a	2,635 a
May 11	31,992 b	6,849 a	2,767 a
May 21	16,341 d	5,212 b	2,057 b
June 1	22,468 c	5,544 b	496 c

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

Appendix Table 15. Date of planting study, 1964. Effect of chemical treatment.

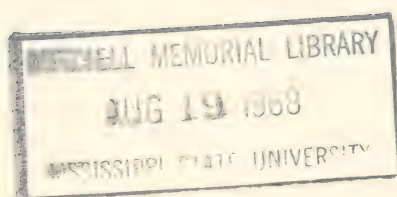
Treatment	Plants per acre <u>1/</u>	Hills per acre <u>1/</u>	Yield, lbs. of seed cotton <u>1/</u>
Ceresan M	20,066 b	5,447 b	2,130 b
Ceresan M + CaSO ₄	21,105 b	5,341 b	2,100 b
Ceresan M + captan & PCNB	23,684 a	5,983 a	2,463 a

1/ Means followed by the same letter are not significantly different at the .05 level as measured by Duncan's New Multiple Range Test.

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Studies Of Interactions Among Chemicals Applied To Cotton At Planting 1965-66



**MISSISSIPPI STATE UNIVERSITY
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Table 1. Chemicals used in interaction studies in 1965 and 1966.

Common name	Trade Name ¹	Chemical composition
<u>Fungicides:</u>		
captan	Captan	N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide
chloroneb	Demosan	1,4-dichloro-2,5-dimethoxybenzene
hexachloro- phene	Nabac	2,2'-methylenebis(3,4,6-trichlorophenol)
Olin 2424	Terrazole	3-trichloromethyl-5-ethoxy-1,2,4-thiadiazole
PCNB	Terrachlor	pentachloronitrobenzene
<u>Herbicides:</u>		
fluometuron	Cotoran	3-(m-trifluoromethylphenyl)-1,1-dimethylurea
propachlor	Ramrod	2-chloro-N-isopropylacetanilide
CP 50144	Lasso	2-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide
diuron	Karmex	3-(3,4-dichlorophenyl)-1,1-dimethylurea
EPTC	Eptam	ethyl N,N-dipropylthiocarbamate
nitralin	Planavin	4-(methylsulfonyl)-2,6-dinitro-N,N-dipropylaniline
trifluralin	Treflan	alpha, alpha, alpha-trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine
<u>Insecticides:</u>		
DuPont 1179	Lannate	methyl N-[(methylcarbamoyl)oxy] thioacetimidate
NIA 10242	Furadan	2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate
phorate	Thimet	O,O-diethyl-S-(ethylthio)methyl phosphorodithioate
!JC 21149	Temik	2-methyl-2-(methylthio)propionaldehyde O-(methylcarbamoyl)oxime

¹Mention of a trade name or a proprietary product does not constitute a guarantee or warranty of the product by the United States Department of Agriculture, and does not imply its approval to the exclusion of other products of a similar nature.

STUDIES OF INTERACTIONS AMONG CHEMICALS APPLIED TO COTTON AT PLANTING

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Since 1961 studies have been conducted at the Delta Branch Experiment Station to evaluate possible interactions among chemicals commonly used at planting. Our intentions in reporting these studies are, to point out the benefit of multiple chemical treatment, and to identify any combinations that might be deleterious.

Most of the combinations of chemical treatments have resulted in excellent pest control, increased stand uniformity, and increased yields. However, a number of deleterious interactions have been noted (3,4,5).

To reduce the possibility of economic loss, new materials are tested in various combinations with chemicals now used, to insure that the new combinations will not reduce stands or yield. It is essential that possible occurrence of damaging interactions be understood before materials are selected for use. This report summarizes studies conducted in 1965 and 1966.

Methods and Materials

Tests were established in a split-plot design to determine both main effects of (and interactions between) chemical treatments. Individual plots were two rows at least 55 feet long. Plantings on 40 - inch rows were hill-dropped on 20-inch centers, with 20 lbs. per acre of Stoneville 7A cottonseed treated with 3 oz. per cwt of 2.2% cyano (Methylmercuri) guanidine (Panogen 15). The chemicals used in these studies are listed in Table 1.

Fungicide treatments were applied as a seed treatment or as a planter - box dust (2). Chloroneb was applied as a slurry, at the rate of 10 ounces of a 65% formulation, to the Panogen 15 treated seed. The other fungicides were mixed with the seed and applied through the planter seedhopper.

Herbicide treatments were applied on a 20-inch band. Trifluralin and nitralin were incorporated with a rolling cultivator in 1965 and Experiment 1 in 1966. A ground-driven double - reel device was used to incorporate nitralin in Experiment 2 in 1966. EPTC-diuron was applied as a 6-8-6 triband treatment (1). Diuron was applied in the center 8-inch band, and EPTC was injected 1-inch deep into the soil to form a 6-inch band on either side of the center diuron band. Other herbicides were applied as pre-emergence treatments to the soil surface in a 20-inch band after planting.

Insecticides were applied with a gravity flow granule applicator, except Dupont 1179 which was applied as a seed treatment. In the 1965 study, insecticide granules were applied through the planter hill-drop unit. In 1966 the granules were applied in the seed drill.

Results

1965 Study — On April 30, 1965, we established a test to evaluate the possible interactions between two preemergence herbicides, a systemic insecticide, and three fungicides applied at planting time on Bosket silt loam.

Stand data indicate that two of the fungicide treatments significantly increased plant populations (Table 2).

The use of these fungicide combinations, PCNB + captan or PCNB + Olin 2424, resulted in plant stand increases of over 10,000 plants per acre. Stand differences due to herbicide or insecticide

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treatments were not significant. None of the interactions among the treatments were significant. While yield increases were associated with the use of multiple pesticide treatments, none were significant.

The grass infestation, evaluated on May 25, was primarily annual grasses and trifluralin provided considerably better control than diuron.

1966 Studies — Two experiments were established to evaluate possible interactions among chemicals applied at planting time.

In the first experiment, on May 10, 1966, we applied two fungicides, four herbicides, and two insecticides on Bosket silt loam.

Stand data (Table 3) indicate that the herbicide trifluralin and the insecticides

UC 21149 and phorate significantly reduced plant stands. Stands with UC 21149 treatment were significantly better than those treated with phorate. Both insecticide treatments gave significant reductions in thrips population. However, control with UC 21149 was significantly better than that obtained with the phorate treatment. Yield data (Table 3) indicate that the use of either of the sys-

temic insecticides resulted in significant increases in yield.

Cotton in all plots treated with UC 21149, regardless of the other pesticides used, was generally delayed in emergence and showed some injury. Injury was most severe where UC 21149 was used in combination with the diuron + EPTC herbicide treatment. However, injury was only temporary and the cotton quickly recovered. During the week after planting there was .5 inch of rainfall and three successive nights with minimum soil temperatures in the 60s at the 2-inch depth. During the 2nd week after planting, moderate cotton injury developed in all plots treated with a combination of phorate and diuron. The injury symptoms were not the typical chlorosis usually associated with diuron toxicity, but started as a mottled green coloration in the leaf tissue and progressed very rapidly to a necrotic condition. The cotyledons had a silvery appearance with necrotic margins.

Weed control was very good to excellent, regardless of the herbicide used. Differences were small, but weed control ratings indicated that fluometuron and diuron + EPTC were superior to trifluralin and diuron.

Table 2. Studies on possible interactions between chemicals used at planting time, 1965. None of the possible interactions among chemicals were significant.

Treatment Chemical Concentration	Rate/A lbs.	Stand Plants/a ¹	Seed cotton, lbs/a	% Weed control
Fungicides:				
None	-0-	17,291 b	2,666	76
Hexachlorophene + captan .75 + 7%	3	21,749 b	2,654	89
PCNB + captan 10 + 10%	3	28,804 a	2,958	82
PCNB + Olin 2424 10 + 5%	3	29,368 a	3,084	81
Herbicides:²				
None	-0-	24,431 a	2,788	68
Diuron	1.0	23,978 a	2,840	78
Trifluralin	1.0	24,501 a	2,892	98
Insecticides:				
None	-0-	24,651 a	2,838	82
Phorate 10%	3.6	23,953 a	2,842	81

¹Means followed by the same letter within pesticide groups are not significantly different at the .01 level of probability as measured by Duncan's New Multiple Range Test.

²Rate per acre of active ingredient on a broadcast basis.

INTERACTION AMONG CHEMICALS

Table 3. Studies on possible interactions between chemicals used at planting, Experiment 1, 1966. The herbicide x insecticide interaction on plants per acre and yield of seed cotton were significant at the .01 level.

per acre and yield of seed cotton were significant at the .01 level.							
Treatment		Rate/A lbs.	Stand plants/a	Thrips/10 plants ¹		Seed Cotton lbs/A ¹	% Weed control 6/21/66
Chemical	concentration			6/8/66	6/16/66		
Fungicides:							
Captan + PCNB	10 + 10%	3.0	20,958 a	106 a	38 a	3,130 a	91
Chloroneb	65%	0.125	20,424 a	112 a	43 a	3,130 a	89
Herbicides ² :							
Diuron + EPTC		1.0 + 1.5	21,567 a	108 a	38 a	3,049 a	90
Fluometuron		1.0	21,332 a	105 a	45 a	3,269 a	95
Diuron		1.0	20,988 a	118 a	36 a	2,997 a	88
Trifluralin		1.0	18,877 b	106 a	42 a	3,205 a	86
Insecticides:							
None		-0-	22,540 a	240 c	58 c	2,498 e	89
UC 21149	10%	5.0	20,679 b	15 a	22 a	3,754 a	90
Phorate	10%	0.0	18,857 c	72 b	40 b	3,118 b	90

¹ Means followed by the same letter within pesticide groups are not significantly different at the .01 probability level as measured by Duncan's New Multiple Range Test.

² Per acre amount of active material on a broadcast basis.

Table 4. Studies on possible interactions between chemicals used at planting time, Experiment 1, 1966. Numerical illustration of herbicide x insecticide interaction on plants per acre.

Herbicide	Insecticide			Average ¹
	None	UC 21149	Phorate	
Trifluralin	19,501	17,879	19,252	18,877 b
Diuron	24,615	23,409	14,927	20,988 a
Diuron + EPTC	22,952	21,497	20,249	21,567 a
Fluometuron	23,077	19,917	20,998	21,332 a
Average ¹	22,540 a	20,679 b	18,857 c	

¹Averages followed by the same letter are not significantly different at the .01 probability level as measured by Duncan's New Multiple Range Test.

Table 5. Studies on possible interactions between chemicals used at planting time, Experiment 1, 1966. Numerical illustrations of herbicide x insecticide interaction on pounds of seed cotton per acre.

Herbicide	Insecticide			Average ¹
	None	UC 21149	Phorate	
Trifluralin	2468	3795	3347	3205 a
Diuron	2426	3864	2700	2997 a
Diuron + EPTC	2373	3681	3090	3049 a
Fluometuron	2743	3701	3358	3269 a
Average ¹	2498 c	3754 a	3118 b	

¹Averages followed by the same letter are not significantly different at the .01 probability level as measured by Duncan's New Multiple Range Test.

The herbicide x insecticide interactions on plant stands and yield of seed cotton per acre were significant.

The interactions between herbicides and insecticides on plant stand are summarized in Table 4. The diuron-phorate, and the trifluralin - UC 21149 treatments resulted in reduced stands. The diuron UC 21149, diuron+EPTC-UC 21149 and trifluralin - phorate treatments had less effect on stands than any of the other combinations.

The interactions between herbicides and insecticides on yield of seed cotton per acre are summarized in Table 5. The diuron - phorate treatment reduced yield more than the other herbicide - insecticide combinations. However, the yield was higher than that obtained where diuron alone was used.

In the second experiment, planted on May 5, two fungicides, three herbicides and three insecticides were applied at planting time on Bosket silt loam.

Data in Table 6 indicate that nitralin significantly reduced stands. The data indicate that the use of a systemic in-

secticide significantly increased yields. Population counts of thrips on June 8 indicate that nitralin gave some control of thrips. However, the UC 21149 - treated plots had significantly fewer thrips than the check or either of the other insecticide treatments. On June 16, UC 21149 did not differ from the check, but both had significantly fewer thrips than the other insecticide treatments. Plots treated with DuPont 1179 had significantly higher thrips counts than the check plots on both June 8 and 16.

The herbicide X insecticide interactions on thrips infestation on June 16 and on yield of seed cotton were significant. The data are summarized in Table 7. The following herbicide - insecticide combinations resulted in reduced insecticidal effectiveness: propachlor - DuPont 1179, propachlor - UC 21149, nitralin - NIA 10242, and CP - 50144 - DuPont 1179.

The interactions between herbicides and insecticides on yield of seed cotton are summarized in Table 8. The Nitralin-UC 21149, and the CP 50144-UC 21149

Table 6. Studies on possible interactions between chemicals used at planting, Experiment 2, 1966. The herbicide x insecticide interaction on thrips infestation at 6/16/66 and yield of seed cotton per acre were significant.

Infestation at 6/16/66 and yield of seed cotton per acre were significant.					
Treatments	Rate/A lbs.	Stand, plants/A ¹	Thrips/100 plants ¹		Seed Cotton lbs/A ¹
			6/8/66	6/16/66	
Chemical — concentration					
Fungicides:					
Chloroneb 65%	0.125	22,650 a	203 a	94 a	3817 a
Captan + PCNB 10 + 10%	3.0	21,676 a	200 a	84 a	3700 a
Herbicides ² :					
Propachlor	4.0	23,223 a	217 b	98 a	3716 a
CP 50144	1.0	23,099 a	240 b	98 a	3736 a
Nitralin	0.5	20,170 b	148	91 a	3823 a
Insecticides:					
DuPont 1179 90%	0.075	22,675 a	312 c	113 b	3739 b
Niagara 10242 10%	5.0	22,540 a	190 b	112 b	3742 b
None	-0-	22,400 a	201 b	72 a	3476 c
UC/21149 10%	5.0	21,043 a	103 a	59 a	4075 a

¹ Data by Student's *t*-test are significantly different at the .05 probability level as measured by Duncan's New Multiple Range Test.

¹Means followed by the same letter are not significantly different at the .05 probability level as measured by Duncan's New Multiple Range Test.²Per acre amount of active material on a broadcast basis.

Table 7. Studies on possible interactions between chemicals used at planting time, Experiment 2, 1966. Numerical illustrations of herbicide x insecticide interaction on thrips counts on June 16, 1966.

Insecticide	Herbicide			Average ¹
	Propachlor	CP 50144	Nitralin	
DuPont 1179	131	121	87	113 b
Niagara 10242	76	100	160	112 b
None	77	57	83	72 a
UC 21149	1.8	34	34	59 a
Average ¹	98 a	78 a	91 a	

¹Averages followed by the same letter are not significantly different at the .05 probability level as measured by Duncan's New Multiple Range Test.

combinations resulted in significantly increased yields, as compared to other herbicide - insecticide combinations. The Nitralin - DuPont 1179, the CP 50144-DuPont 1179, and the CP 50144 - NIA 10242 combinations resulted in reduced yields compared to other combinations. Propachlor - treated plots yielded well with any of the insecticide treatments, but better with an insecticide than without.

Discussion

The use of a fungicide treatment at planting time resulted in improved stands. The use of any commercially available systemic insecticide at planting time resulted in reduced stands. However, use of the systemic insecticides phorate and UC-21149 resulted in increased yields. Of the herbicides tested, only trifluralin and nitralin reduced stands. Yields were not reduced by any of the herbicide treatments.

Several herbicide - insecticide combinations resulted in reduced stands and yields. The combinations of diuron-phorate and trifluralin - UC 21149 were re-

sponsible for stand reductions. The following combinations resulted in reduced yields, as compared to other herbicide-insecticide combinations:

Diuron — phorate
Nitralin — DuPont 1179
CP 50144 — DuPont 1179
CP 50144 — NIA 10242

While several combinations of chemical treatments were found to be deleterious, most resulted in increased production. The results clearly show that several fungicide - herbicide - insecticide combinations reduce stand losses, give effective weed and thrips control without damage to the crop, and contribute to maximum yields.

This is a report on the current status of research on best control practices. It does not contain recommendations for the use of pesticides, nor does it imply that the uses discussed have been registered. All uses of pesticides must be registered by appropriate State and Federal agencies before they can be recommended.

Table 8. Studies on possible interactions between chemicals used at planting time, Experiment 2, 1966. Numerical illustrations of herbicide x insecticide interaction on yield of seed cotton, pounds per acre.

Insecticide	Herbicide			Average ¹
	Propachlor	CP 50144	Nitralin	
DuPont 1179	3891	3669	3659	3739 b
Niagara 10242	3726	3665	3837	3742 b
None	3419	3443	3564	3476 c
UC 21149	3829	4166	4231	4075 a
Average ¹	3716 a	3736 a	3823 a	

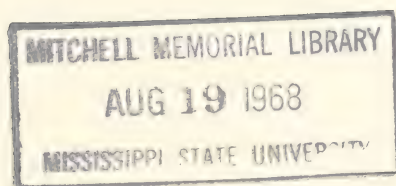
¹Averages followed by the same letter are not significantly different at the .05 probability level as measured by Duncan's New Multiple Range Test.

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Dried Bakery Products In Broiler Diets

By ELBERT J. DAY and BEN C. DILWORTH



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Summary

A relatively new by-product, dried bakery product, was fed to broilers in battery and floor studies at dietary levels of 0, 5, 10 and 15%. All diets were formulated to be equal in nutrient content using a computer.

Results from both studies indicate that the diets were nutritionally equal. There were no statistically significant differences found for either growth rate or feed utilization in either study. These data clearly demonstrates that the nutrient values which were assigned to the dried bakery product are correct for the growing broiler.

These results also show that this feed-stuff can be used safely in broiler diets at the 15% dietary level.

DRIED BAKERY PRODUCTS IN BROILER DIETS

By ELBERT J. DAY and BEN C. DILWORTH¹

Predictions of a world wide food shortage emphasize the need to increase the food supply and reduce needless waste. Feed manufacturing and livestock industries have excelled in producing human food from what was formerly considered waste products or by-products. The so called by-products from the meat packing, fermentation, brewing, milk processing, oilseed processing and wheat and corn milling industries are being incorporated into animal feeds and converted to highly desirable human foods.

Until just recently, one neglected valuable by-product source was the baking industry. Literally thousands of tons of bakery materials have been lost because suitable handling procedures were not developed to assume that the product would be uniform and of high nutritional quality.

Fairly recently, a few large service companies have been established which have long-term contracts with various national bakeries, cookie manufacturers, and processors of baked "snack items," to collect all of their bakery by-products and returned goods on a routine basis in sanitary containers. In turn, these specialized companies have developed automatic equipment which separates out the extraneous materials and salvages, blends, and dries, the resulting feedstuff. As extremely large amounts of materials from many different sections of the U.S. are assembled at any one plant location, it is possible for such organizations to

blend the various types of bakery products so that an extremely uniform feed ingredient results. The materials are now handled in such a speedy manner that no spoilage occurs prior to processing.

The American Association of Feed Control Officials recognizes this ingredient under the official name of "dried bakery product." One of the leaders in this industry has marketed a material known as "blended DBP"* in large quantities for several years in the southern area of the U.S. Since only a limited number of experiments with poultry have been conducted in the past to evaluate this feed ingredient, the following trials were conducted at the Mississippi Agricultural Experiment Station.

Procedure

A battery study of 4 weeks and a floor study of 8 weeks duration were conducted with day-old broiler cockerels obtained from a commercial hatchery. The battery study was initiated July 26, 1967 and the floor study October 17, 1967. A sufficient supply of DBP was obtained prior to starting each experiment so that only one sample was used in each test. Six lots of 10 birds each were fed each diet in the battery study and triplicate lots of 75 birds each were fed each diet in the floor study. Group feed consumption and individual body weight records were obtained at the end of the battery experiment. In the floor study these records were obtained for each group at 32 and 56 days of age. Light, feed and water were provided continuously. Mortality records were kept on a daily basis.

Experimental diets containing 0, 5, 10 and 15% DBP were formulated with the

¹Poultryman and assistant poultryman, Mississippi Agricultural Experiment Station.

*Registered trademark of the International Fortriton Co., Inc., Atlanta, Georgia.

Table 1. Composition of the broiler starter diets.

Ingredient (\$/cwt) ¹	Percentage Composition			
	Diet 1	Diet 2	Diet 3	Diet 4
Yellow corn (2.630)	58.22	54.10	49.97	44.86
Soy, 50% (4.450)	28.53	28.23	27.93	27.54
Fish, Peruvian (6.700)	5.00	5.00	5.00	5.00
Alfalfa, 17% (2.900)	1.14	1.43	1.72	2.69
Poultry oil (5.500)	4.12	3.47	2.81	2.50
Dical. Phos. (3.973)	1.28	1.25	1.22	1.19
Limestone (0.490)	.76	.75	.75	.80
3-Nitro, 10% (32.000)	.05	.05	.05	.05
Zoamix (215.000)	.05	.05	.05	.05
Fortracin-10 (50.000)	.025	.025	.025	.025
Broiler vit. ² (24.390)	.25	.25	.25	.25
Salt (1.000)	.525	.350	.175	-----
Bakery product (2.917)	-----	5.00	10.00	15.00
Meth., DL (100,000)	.048	.048	.048	.049
Total	100.00	100.00	100.00	100.00
Cost, \$/ton	74.015	73.879	73.742	73.801

¹ Delivered ingredient prices to a central Mississippi broiler producer (July, 1967).

² The broiler premix provided the following amounts of other ingredients per pound of feed: Vitamin A, 2500 IU; vitamin D₃ 750 ICU; vitamin E, .5 IU; riboflavin, 2.0 mg.; niacin, 1.25 mg.; d-pantothenic acid, 4.0 mg.; folic acid, 62.5 mcg.; vitamin B₁₂, 4 mcg.; choline chloride, 225 mg.; ethoxyquin, 25 mg.; menadione sodium bisulfite, 0.63 mg.; manganese, 66.25 ppm; zinc, 44 ppm; iodine, 1.25 ppm; iron, 20 ppm; copper, 2 ppm and cobalt, .2 ppm.

Table 2. Composition of the broiler finisher diets

Ingredient (\$/cwt) ¹	Percentage Composition			
	Diet 1	Diet 2	Diet 3	Diet 4
Yellow corn (2.630)	65.03	60.91	56.78	52.56
Soy, 50% (4.450)	20.18	19.88	19.58	19.27
Fish, Peruvian (6.700)	5.00	5.00	5.00	5.00
Alfalfa, 17% (2.900)	2.57	2.86	3.15	3.51
Poultry oil (5.500)	4.43	3.78	3.12	2.50
Dical. phos. (3.973)	1.16	1.13	1.10	1.07
Limestone (0.490)	0.67	0.66	0.66	0.66
3-Nitro, 10% (32.000)	0.05	0.05	0.05	0.05
Zoamix (215.000)	0.05	0.05	0.05	0.05
Fortracin-10 (50.000)	.025	.025	.025	.025
Broiler vit. (24.390)	0.25	0.25	0.25	0.25
Salt (1.000)	.525	.350	.175	-----
Bakery product (2.917)	-----	5.00	10.00	15.00
Meth., DL (100,000)	.062	.062	.061	0.61
TOTAL	100.002	100.007	100.001	100.006
Cost, \$/ton	71.499	71.362	71.226	71.108

¹ See footnotes, Table 1.

aid of a computer, Tables 1 and 2. All diets contained essentially identical levels of energy, calcium, available phosphorus, methionine, methionine plus cystine, lysine, sodium chloride and xanthophyll (Tables 3 and 4). It can be seen from the diet composition tables that DBP is primarily an energy source. As the dietary level of DBP increases, the percentage of corn and supplementary

fat decreases. In these studies DBP was considered to contain 8.5% protein, 1350 productive Calories per pound, 0.32% lysine, 0.16% methionine, 0.34% methionine plus cystine, 0.8 mg. xanthophyll per pound and 3.5% sodium chloride. The high salt content of DBP is the prime factor governing the maximum usage level of this product in poultry rations. The diet containing 15% DBP did not

Table 3. Characteristics of the broiler starter diets¹

Criteria	Restriction ²	Actual amounts			
		Diet 1	Diet 2	Diet 3	Diet 4
Crude protein %	UR	22.83	22.79	22.75	22.70
Total fat, %	UR	6.838	6.677	6.517	6.671
Crude fiber, %	UR	2.427	2.483	2.539	2.746
Prod. Energy, Cal./lb. exact	1055	1055	1055	1055	1055
Calcium, %	0.92-0.95	0.92	0.92	0.92	0.95
Avail. phos., min. %	0.46	0.46	0.46	0.46	0.46
Total phos., %	UR	0.70	0.69	0.69	0.68
Arginine, min. %	1.147	1.568	1.554	1.540	1.522
Lysine, Min. %	1.329	1.329	1.329	1.329	1.329
Methionine, min. %	0.443	.456	.455	.454	.453
Meth. + cystine, min. %	0.823	.823	.823	.823	.823
Tryptophane, min. %	0.223	.311	.308	.305	.303
Xanthophylls, min. mg/lb	5.80	5.80	5.80	5.80	6.40
Added fat, min. %	2.50	4.12	3.47	2.8 ¹	2.50
Total salt, % ³	.525	.525	.525	.525	.525

¹Linear programmed diets.²Dietary restrictions the computer had to meet in formulating the diet. UR means unrestricted.³The Bakery Product was considered to contain 3.5% salt. The total dietary level was calculated using only that furnished by the bakery product and added salt.Table 4. Characteristics of the broiler finisher diets¹

Criteria	Restriction ²	Actual amounts			
		Diet 1	Diet 2	Diet 3	Diet 4
Crude protein, %	UR	19.50	19.46	19.42	19.38
Total fat, %	UR	7.38	7.22	7.06	6.93
Crude fiber, %	UR	2.713	2.770	2.826	2.898
Prod. energy, Cal./lb. exact	1080	1080	1080	1080	1080
Calcium, exact %	.86	.86	.86	.86	.86
Avail. phos., %	.43	.43	.43	.43	.43
Total phos., min. %	UR	.65	.64	.63	.62
Arginine, min. %	1.147	1.293	1.279	1.264	1.250
Lysine, min. %	1.080	1.080	1.080	1.080	1.080
Methionine, min. %	.388	.426	.425	.424	.423
Meth. + cys., min. %	.747	.747	.747	.747	.747
Tryptophane, min. %	.223	.258	.255	.252	.250
Xanthophylls, min. mg/lb	7.77	7.77	7.77	7.77	7.83
Added fat, min. %	2.50	4.43	3.78	3.12	2.50
Total salt, % ³	.525	.525	.525	.525	.525

¹Linear programmed diets.²Dietary restrictions the computer had to meet in formulation diets. UR means unrestricted.³The Bakery Product was considered to contain 3.5% salt. The total dietary salt level was calculated using only that furnished by the bakery product and added salt.

contain any added salt per se.

Body weight and feed utilization data from both experiments were subjected to statistical analysis procedures.

Results

Final average body weights and feed efficiency records for the birds in the battery study were essentially the same

for all diets (Table 3). None of the differences were statistically significant indicating that the nutrient values assigned to DBP are essentially correct for the broiler.

Since it is difficult to get highly accurate feed efficiency data in batteries using small numbers of birds for a short period of time a floor study using 75

birds per pen was conducted. All birds were switched to a finisher diet at 32 days of age; however, the finisher diets contained the same dietary level of DBP as the starter diets (Table 2).

Chick performance did not differ statistically for the various dietary treatments in the floor study (Table 4). These data are in agreement with the results from the battery study, which indicate that the nutrient values assigned to DBP are essentially correct. Best performance was obtained from the birds fed the diet containing 5% DBP, but again, these differences were not statistically significant.

From the results of this study, one can only conclude that all diets supported equal performance. Mortality in both experiments was low and considered not to be influenced by diet.

Economic Evaluation

An economic evaluation of DBP was made using the results from the large

floor experiment and the computed cost of each diet. In this evaluation, 100 pounds of DBP was considered to cost \$2.917, which was equal to the cost of 90 pounds of yellow corn and 10 pounds of fat. All other ingredient prices were based on the average delivered prices to a Central Mississippi broiler producer during July, 1967.

The use of DBP resulted in a slight reduction in the feed cost required to produce 100 pounds of broiler meat (Table 7). There may be other savings associated with the use of DBP such as not having to grind it as is required with the cereal grains. Also, there is considerable shrinkage during the grinding process which would be avoided with the use of DBP. The high fat content of DBP is certainly a favorable physical characteristic since fat tends to reduce dustiness and loss during normal handling procedures.

Table 5. Effect of "Dried Bakery Product" on broiler performance

Diet Number	Bakery Product,% ¹	Four week average weight, g ²						Av. ³
		Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	
1	— — —	667	691	660	667	718	770	696
2	5.0	665	645	714	668	731	728	692
3	10.0	662	711	692	677	737	730	702
4	15.0	613	675	676	723	706	734	688

1	— — —	Four week average feed/gain						1.52
		1.57	1.56	1.41	1.58	1.50	1.52	
2	5.0	1.60	1.64	1.49	1.43	1.42	1.56	1.52
3	10.0	1.58	1.51	1.53	1.46	1.48	1.52	1.51
4	15.0	1.70	1.47	1.44	1.49	1.60	1.49	1.53

¹ See Tables 1 and 3 for the ration characteristics and composition, respectively.

² All lots (10 broiler cockerels each) of chicks were maintained in electrically heated battery brooders for a test period of four weeks beginning at one day of age, July 26, 1967. The test diets and tap water were provided ad libitum. Livability was 99.6% and apparently unaffected by the dietary modifications.

³ No significant differences.

DRIED BAKERY PRODUCTS IN BROILER DIETS

Table 6. Effect of "Dried Bakery Product" on broiler performance¹

Diet number	Dietary Bakery Product, %	32 day average wt., lbs. ²				56 day average wt., lbs. ²			
		Lot 1	Lot 2	Lot 3	Av.	Lot 1	Lot 2	Lot 3	Av.
1	—	1.74	1.69	1.72	1.72	4.16	4.01	4.18	4.12
2	5.0	1.73	1.69	1.73	1.72	4.20	4.11	4.22	4.18
3	10.0	1.68	1.71	1.70	1.70	4.04	4.13	4.07	4.08
4	15.0	1.76	1.74	1.68	1.73	4.13	4.16	4.09	4.13

		32 day feed/gain ²				56 day feed/gain ²			
		Lot 1	Lot 2	Lot 3	Av.	Lot 1	Lot 2	Lot 3	Av.
1	—	1.70	1.70	1.71	1.70	2.10	2.16	2.12	2.13
2	5.0	1.72	1.70	1.74	1.72	2.08	2.13	2.10	2.10
3	10.0	1.72	1.70	1.73	1.72	2.14	2.09	2.14	2.12
4	15.0	1.70	1.70	1.74	1.71	2.12	2.13	2.14	2.13

¹ Each lot consisted of 75 broiler cockerels at the beginning of the test, October 17, 1967. Beginning at 43 days of age at the onset of a respiratory infection, all birds were treated for 3 days with tylosin in the drinking water (2 g/gal). Aureomycin (200g/ton) was fed to all lots from 43 days to 56 days of age.

² No significant differences were found in broiler performance. The 0-56 day livability was as follows: Diet 1, 97.3%; Diet 2, 95.6%; Diet 3, 95.1% and Diet 4, 97.3%.

Table 7. Broiler performance cost data¹

Diet number	Dietary Bakery Products, %	Starter, 0-32 days, \$/cwt. meat	Finisher 33-56 days \$/cwt. meat	Total cost, \$/cwt. meat
1	—	6.31	8.73	7.70
2	5.0	6.36	8.53	7.61
3	10.0	6.34	8.65	7.67
4	15.0	6.32	8.69	7.67

¹ The approximate feed consumption of the chicks fed each diet was: Starter (0-32 days), 34%; finisher (33-56 days), 66%. The approximate relative weight gain during each growth was: Starter, 43%; finisher, 57%.



Crop Response To Lime On Loess Soils

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Summary

Experiments were conducted on Brown Loam soils at Holly Springs and Raymond to determine the effects of source (calcite and dolomite), placement (on the soil surface and mixed with the surface 6 inches), and rate (0 to 7 tons) of lime on yield of alfalfa, white clover, and Coastal bermudagrass. The results are summarized as follows:

Calcitic and dolomitic limestone sources produced similar yields for any given crop.

Placement of lime on the soil surface or mixed with the top 6 inches of soil produced similar yields for any given crop. Lime significantly increased the yield of alfalfa and white clover during each year of the study. Rates greater than 1 ton per acre did not further increase white clover yields, and rates greater than 3 tons did not further increase alfalfa yields. Alfalfa did not respond to molybdenum.

Lime significantly increased the yield of Coastal bermudagrass on Grenada silt loam at Holly Springs during the last two years of a 4-year study but was ineffective on Filaya silt loam at Raymond.

Liming substantially reduced the exchangeable manganese and aluminum in the surface 6 inches of Grenada silt loam which may be important in preventing die out of alfalfa. Furthermore, liming and fertilizing the surface soil with 400 pounds of N per acre per year created a more favorable chemical environment for roots in the subsoil.

CROP RESPONSE TO LIME ON LOESS SOILS

J. O. SANFORD¹, D. L. MYHRE², B. L. ARNOLD³, and R. E. COATS³

The Loess or Brown Loam area is one of the leading cattle-producing areas of Mississippi. The higher production of better quality forages needed to sustain this industry requires higher rates of nitrogen fertilizer. Since high nitrogen rates may lead to soil acidity, this would intensify the need for lime⁴. Already the use of lime in the Brown Loam is known to be far short of needs⁵.

While it is generally recognized that lime must be applied to most Brown Loam soils for growth of alfalfa and white clover, little information is available concerning the response of Coastal bermudagrass to lime on these soils.

The purposes of this study were to determine the response of alfalfa, white clover, and Coastal bermudagrass to both calcic lime (calcite) and dolomitic lime (dolomite) on Brown Loam soils and the effects of these sources on certain soil properties, especially pH.

Experimental Procedure

Two experiments were conducted at each of two locations as described in Table 1.

A split-plot experimental design with treatments replicated four times was used at all locations. Calcite applied on the surface, dolomite applied on the surface, and dolomite mixed with the top 6 inches of soil were the three whole-plot treatments. Five rates of lime were the sub-plot treatments. The liming rates and criteria for establishing these rates are shown in Table 2.

Fertilizer for establishment and annual maintenance for each experimental site was applied at the rate of 100 pounds per acre each of P_2O_5 and K_2O . An additional 15 pounds of fertilizer-grade borax was included in the establishment fertilizer for alfalfa.⁶ In addition, Coastal bermuda-

grass received 100 pounds of N as ammonium nitrate before growth started in the spring and after each clipping except the last clipping in the fall. Coastal was clipped once in 1959, twice in 1960, and three times in 1961 and 1962. A fourth clipping was made at Raymond in 1961.

Molybdenum treatments were superimposed on the dolomitic lime treatments in the alfalfa experiment during the fifth year. For this study, the old alfalfa stand was plowed and disked in the fall of 1962. Two ounces of molybdenum per acre in superphosphate was broadcast on one-half of the renovated plots prior to disking. Plots were then reseeded.

Oven-dry yields were determined by clipping a 5- x 20-foot area in the center of each plot. No yield data were obtained for white clover in 1960 due to loss of stand.

¹Contribution from the Southern Branch, Soil and Water Conservation Research Division, Agricultural Research Service, USDA, in cooperation with the Mississippi Agricultural Experiment Station.

²Research Soil Scientists, USDA, State College, Mississippi.

³Agronomist, North Mississippi Branch Experiment Station, Holly Springs, Mississippi; and, Superintendent, Black Belt Branch Experiment Station⁴ Brooksville, Mississippi (formerly Agronomist, Brown Loam Branch Experiment Station Raymond, Mississippi) respectively.

⁴Jones, U. S., and C. Dale Hoover. 1953. More lime needed with change in nitrogen picture. Mississippi Farm Research 16(4):8.

⁵Data furnished by L. E. Gholston, Soil Testing Service, State College, Mississippi.

⁶Arnold, B. L. 1961. Good hay crop from alfalfa in North Mississippi. Mississippi Farm Research 24(10):1,4.

Soil samples from the top 6 inches of each plot were collected in March of each year for pH measurement. Additional soil samples were collected in 1964 6 years after liming from the no-lime and 4.8-ton-per-acre calcite treatments of the grass experiment at Holly Springs for measurements of pH, calcium (Ca) aluminum (Al) and manganese (Mn).

Results and Discussion

The following statements can be made for all experiments: (1) Similar yields for a given crop were produced by either calcite or dolomite; (2) method of application of dolomite made no difference in the yield of a given crop; and (3) calcite tended to produce a slightly higher pH than did dolomite, but this was of no importance in crop production.

Since source and method of application of lime produced no yield difference, data presented for rates of lime are for main effects.

Effect of lime on alfalfa and white clover: Each increment of lime increased the yield of alfalfa on Grenada silt loam (pH 5.3) each year of the 4-year study. The greatest increase was obtained with the first increment of lime applied 1.5 tons per acre; however, the yield increase obtained from the 3-ton-per-acre treatment was also significant (Table 3). Differences among the 3-, 4.5-, and 6.75-ton-per-acre rates were not significant. This indicates that the soil test accurately predicted the lime requirement.

During the first season alfalfa began to "die out" on the no-lime treatment, and by the end of the fourth year had completely disappeared on many of these plots. Throughout the study, plants that survived on the no-lime plots were light green to pale yellow.

Molybdenum added to the soil in the fifth year did not affect the yield or color of alfalfa.

In view of the high amount of exchangeable manganese found in the un-

Table 1. Experimental locations, soils and crops.

Location	Soil type	Initial pH	Crop grown	Date crop established	No. years' data
Holly Springs	Grenada si 1	5.3	Alfalfa (Buffalo)	Fall 1958	4
Holly Springs	Grenada si 1	5.7	Coastal bermuda	Spring 1959	4
Raymond	Falaya si 1	5.5	White clover	Fall 1958	3
Raymond	Falaya si 1	5.5	Coastal bermuda	Spring 1959	4

Table 2. Rates of lime used at each location.

Rate No.	Criteria	Lime Rate	
		Holly Springs	Raymond ¹
		Alfalfa	C.B.
		tons/acre	
1	No lime, check	0	0
2	One-half of rate no. 3	1.5	1.0
3	Lime requirement as per soil test	3.0	2.2
4	Amount required to raise soil pH to 7.0	4.5	3.2
5	50% more than amount required to raise pH to 7.0	6.75	4.8
			7.5

¹ Rates were the same for both white clover and Coastal bermudagrass at Raymond.

limed surface soil in the Coastal experiment (Table 5), manganese and/or aluminum toxicity probably caused the die out. Liming reduced exchangeable manganese and aluminum to levels alfalfa can tolerate.

White clover showed a significant yield response to lime during each year of the study. One ton of lime increased the yield of clover forage by 458 pounds per acre in 1959, 1169 pounds in 1961, and 1441 pounds in 1962. Rates greater than 1 ton per acre did not further increase yields (Table 3).

Effect of lime on Coastal bermudagrass: Lime improved the yield of Coastal bermudagrass on Grenada silt loam at Holly Springs during the last two years of the 4-year study but was ineffective on Falaya silt loam at Raymond (Table 4). One ton of lime tended to improve the yield at Raymond but the small increase was not significant. The lower yields in 1959 and 1960 at both locations reflect the difficulty in establishing a good stand due to competition from weeds and other grasses. Although Coastal was sprigged in the spring of

Table 3. Yield of alfalfa and white clover as influenced by rate of lime.

Lime treatment tons/acre	pH of soil		4-Year Average Yields ¹ 1959-1962 lbs/acre
	1959	1962	
Alfalfa on Grenada silt loam at Holly Springs			
0	5.3	5.4	3096 a
1.5	5.6	5.9	6774 b
3	5.9	6.1	7315 c
4.5	6.0	6.3	7492 c
6.75	6.3	6.6	7606 c
White clover on Falaya silt loam at Raymond			
0	5.8	5.2	2357 a
1	6.3	5.7	3380 b
3	6.6	6.3	3338 b
5	6.8	6.5	3322 b
7.5	7.0	6.7	3298 b

¹ Means followed by the same letter are not significantly different at the 5% level of probability.

Table 4. Yield of Coastal bermudagrass as influenced by rate of lime.

Lime	pH of soil		Yield of forage ¹				
treatment	1959	1962	1959	1960	1961	1962	Mean
tons/acre	lbs/acre						
Grenada silt loam at Holly Springs							
0	5.6	5.3	3474 a	6211 a	8349 a	13935 a	7992 a
1.05	6.0	5.8	3594 a	5957 a	8899 ab	14662 b	8278 ab
2.15	6.3	6.1	3594 a	6265 a	9813 c	15104 c	8694 bc
3.2	6.4	6.3	3834 a	6800 a	9550 bc	15399 cd	8896 c
4.8	6.6	6.7	3848 a	7198 a	9521 bc	15653 d	9055 c
Falaya silt loam at Raymond							
0	5.5	5.3	3663	5275	10193	10846	7494 a
1	6.0	5.8	3844	5401	10468	11267	7745 a
3	6.4	6.5	4026	5427	10029	11562	7761 a
5	6.6	6.8	3919	5703	10115	11320	7764 a
7.5	6.8	7.0	3793	5928	9927	11351	7750 a

¹ Means within a column followed by a common letter are not significantly different at the 5% level of probability.

Table 5. The effects of lime on certain chemical properties of Grenada silt loam 6 years after liming and continuous cropping to Coastal bermuda, Holly Springs, Mississippi.

Profile depth	Lime Treatment							
	No lime				4.8 tons calcite/acre			
	Exchangeable				Exchangeable			
	pH	Ca	Al	Mn	pH	Ca	Al	Mn
(in)			lbs/acre				lbs/acre	
0-6	5.4	1120	106	180	7.4	4240	36	32
6-12	5.2	1160	152	90	6.2	2560	108	48
12-24	5.2	880	214	60	5.3	1280	200	56

1958 and sprayed for weed control several times, a pure stand was not obtained until late in the summer of 1960.

The high forage production of about 8 tons per acre in 1962 on Grenada silt loam was obtained with about 20 inches of rainfall distributed in June, July, August, and September. This level probably represents the potential forage production on this type of soil under intensive management. During the same summer period, about 6 tons of forage were produced on Falaya silt loam soil with only 7 inches of rainfall. However, the soil profile was probably near field capacity at the beginning of this 4-month period.

Effect of lime on pH and other soil properties: A lime application of about 2 tons per acre to Brown Loam soils with an initial pH of 5.3 maintained the pH near 6.0 for at least 4 years after application (Tables 2 and 3). The study was terminated before the pH showed signs of declining.

The importance of liming soils to prevent the development of subsoil acidity and increased availability of aluminum and manganese is clearly demonstrated in Table 5. For example, the pH in the 0 - to 6-inch layer of unlimed soil chang-

ed from 5.7 to 5.4, but, of even greater significance, the subsoil pH changed from 5.5 to 5.2. A 4.8-ton application of lime to the surface soil raised the pH to 6.2 in the 6-to 12-inch zone and reduced exchangeable aluminum and manganese. These chemical changes undoubtedly created a more favorable subsoil environment for growth and development of roots.

Recommendations

For alfalfa and white clover, 3 tons per acre of either calcic or dolomitic lime should be applied initially to Brown Loam soils if the pH is about 5.3. This quantity of lime should maintain the pH above 6.0 for about 5 years. Additional lime should be applied in accordance with soil test recommendations to maintain the soil pH above 6.0.

For Coastal bermudagrass, sufficient lime should be applied to bring the pH up to 5.5 - 6.0. The pH of the surface 6 inches should be maintained within this range by surface applications of lime. It is especially important to maintain a liming program for Coastal bermudagrass to prevent the development of subsoil acidity even though the surface soil may have a pH of about 5.5.



The Effects Of Combinations Of Preemergence Herbicides And Systemic Insecticides On Cotton Stands And Yields

By

H. W. IVY and T. R. PFRIMMER



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Glossary of Pesticides

Common Name	Trade Name
trifluralin	Treflan
nitralin	Planavin
diuron	Karmex
fluometuron	Cotoran
norea	Herban
disulfoton	Di-Syston
phorate	Thimet
UC-21149	Temik

THE EFFECT OF COMBINATIONS OF PREEMERGENCE HERBICIDES AND SYSTEMIC INSECTICIDES ON COTTON STANDS AND YIELDS

By H. W. IVY and T. R. PFRIMMER¹

Systemic insecticides applied at planting sharply reduce the need for applications of insecticides early in the season and thus eliminate much labor. Also, systemic insecticides applied in the seed drill at planting have generally provided good to excellent control of thrips (*Thripidae*) for 4 to 5 weeks. Figure 1 shows four plots of cotton treated with a common herbicide and the difference in the size of the cotton plants when a systemic insecticide was added to control thrips.

Researchers at many locations have shown that the phytotoxic properties of combinations of insecticides and herbicides may increase injury to the cotton above the level expected from the use of either chemical alone. This interaction between herbicides and systemic insecticides has been studied at the Delta Branch Experiment Station for four years. Results have been variable, primarily because unfavorable weather often influences stands and yields more than any combinations of pesticides.

The present study was therefore made to obtain additional information about the toxicity of combinations of herbicides and systemic insecticides to cotton and especially on their effects on emergence, growth, and yield. Specifically, the research was designed to find combinations that cause the least damage. Thus, trifluralin and nitalin (see glossary for common names and trade names of chemicals) were applied before planting and were incorporated into the soil with a ground-driven, double lawn mower

reel, diuron, fluometuron, and norea were applied to the surface at planting, and disulfoton, phorate, and Union Carbide UC-21149, 2-methyl-2-(methylthio) propionaldehyde-0-(methylcarbamoyl)oxime, were metered into the seed furrow as granules. Stoneville 7A cottonseed treated with 3 oz of 2.2% cyano(methylmercuri) guanidine and 10 oz. of a 65% formulation of chloroneb per hundred weight of seed was planted. The experiment was conducted as a split-plot design with 56 treatments consisting of 14 herbicides (main plot treatments) and four insecticides (sub-plot treatments) replicated six times using plots two rows wide and 55 feet long.

Results and Discussion

No valid measure of comparative weed control was obtained in the study. All herbicides were applied at the rate recommended by the Mississippi Weed Committee, and all treatments provided good to excellent control. However, plots treated with both preplanting and pre-emergence herbicides generally had slightly better control than plots treated with either herbicide alone though such differences were too small to permit valid measurement.

The predominant weeds were annual grasses and the greatest improvement in control obtained when both preplant and pre-emergence herbicides were used occurred in fields infested with annual grasses and broadleaf weeds, especially when large seeded broadleaf weeds such as morningglory and prickly sida (tea-weed) predominated.

Thrips counts were made on three dates to obtain a comparative evaluation of the insecticides treatments. Table 1

¹Assistant Plant Physiologist, Delta Branch of the Mississippi Agricultural Experiment Station and Entomologist, Entomology Research Division, Agr. Res. Serv., USDA, Stoneville, Mississippi, respectively.

Table 1. The effect of insecticide, herbicide treatments at planting on stand, thrips population, and yield of cotton, Stoneville, Mississippi, 1967.

Insecticide in drill lb/acre	Hills/acre	Plants/acre	Seed cotton	Thrips/10 plants		
	July 5	July 5	lb/acre	5/18	5/25	6/5
Phorate, 0.75	6101c ^a	27335b	2326c	5.6b	11.3b	8.4b
Disulfoton, 0.75	6231b	32447a	2456b	5.0b	9.5b	6.4b
UC-21149, 0.75	6046c	23303c	2611a	1.1c	3.0c	2.9c
None	6322a	33418a	2069d	13.4a	16.3a	19.8a

^aValues in a column followed by a common letter are not significantly different at the 5% level of confidence (Duncan's multiple range test).

shows that UC-21149, phorate, and disulfoton, each at 0.75 lb./acre, significantly reduced populations below that of the control (untreated), and UC-21149 gave significantly better control than disulfoton or phorate. Since the tests were made during adverse weather when timely application of postemergence insecticides would not have been possible, the benefit from the systemic insecticides is apparent.

The average yield of all plots treated with UC-21149 was 2611 lb. seed cotton/acre, an increase of 542 lb./acre over untreated plots (Table 1). Yields in plots treated with disulfoton and phorate were less than those treated with UC-21149 but all were significantly higher than those from plots receiving no insecticide.

As shown in Figure 2, higher yields were produced by preplant treatment with nitralin than with trifluralin, regardless of the insecticide used. Yields with nitralin were also generally higher than those obtained by preemergence treatment with fluometuron or diuron though the yields resulting from preemergence treatment with norea closely approximated those obtained with nitralin. Diuron was generally the optimum preemergence herbicide for use with preplant applications of either trifluralin or nitralin, and plots treated with trifluralin + diuron produced higher yields than those treated with nitralin + diuron, regardless of the insecticide used. Also, highest yields were produced by using UC-21149 with all herbicides except fluometuron.

When no insecticide was applied, treatment with trifluralin + diuron resulted in higher yields than preemergence treatment with norea or fluometuron after preplant treatment with trifluralin. Similarly, the combination of nitralin + diuron resulted in higher yields than were obtained with either of the other preemergence herbicides. No significant difference in yield was found between treatments with trifluralin and nitralin when no insecticide was applied.

When disulfoton was used as the insecticide, treatment with trifluralin + diuron resulted in higher yields than treatment with trifluralin + norea or trifluralin + fluometuron. When diuron and fluometuron were used with nitralin and disulfoton, the yield was better than when norea was used with nitralin and disulfoton.

When phorate was used as the insecticide no significant differences in yield were apparent when trifluralin was used as a preplanting treatment, regardless of which preemergence treatment was used. However, with phorate + nitralin, higher yields were produced when diuron was used as a preemergence treatment than when norea or fluometuron were so used. Use of trifluralin in combination with norea or fluometuron, after treatment with phorate, produced higher yields than the same combinations with nitralin. However, trifluralin and nitralin used with diuron after treatment with phorate produced essentially equal yields.



Figure 1. All plots were treated with the same herbicide fluometuron, 1.5 lb/acre (C-2059) + nitratin, 0.75 lb/acre (SD-11831). Note increased growth in plots also treated with phorate, disulfoton (Di-Syston), and UC-21149 as a result of thrips control.

As previously indicated, highest yields were generally produced in plots treated with UC-21149. When this insecticide was used, treatment with trifluralin + diuron produced higher yields than either norea plus trifluralin or fluometuron + trifluralin. Also, with this insecticide, nitralin + diuron and nitralin + fluometuron produced essentially equal yields, and nitralin + diuron produced yields significantly higher than those produced by nitralin + norea.

The stands were affected by the combinations of herbicides and systemic insecticides. Plots receiving no insecticide averaged 33,000 plants/acre compared with 32,000 plants/acre in plots treated with disulfoton, but phorate and UC-21149 significantly reduced the stands. However, even though many treatments reduced stands 10,000 and 12,000 plants -

acre, they were not generally reduced sufficiently to have any effect on yields.

Combinations giving lowest stands were trifluralin + norea + UC-21149, nitralin + norea + UC-21149, norea + UC-21149, nitralin + UC-21149, nitralin + fluometuron + UC-21149, and trifluralin + diuron + UC-21149.

A significant interaction occurred between the herbicides and the insecticides on the yield of seed cotton and the stands. However, additional information is needed on the compatibility of systemic insecticides and herbicides to permit use of those combinations that are most advantageous. The present data indicate interesting trends, but additional work is needed to verify the indications.

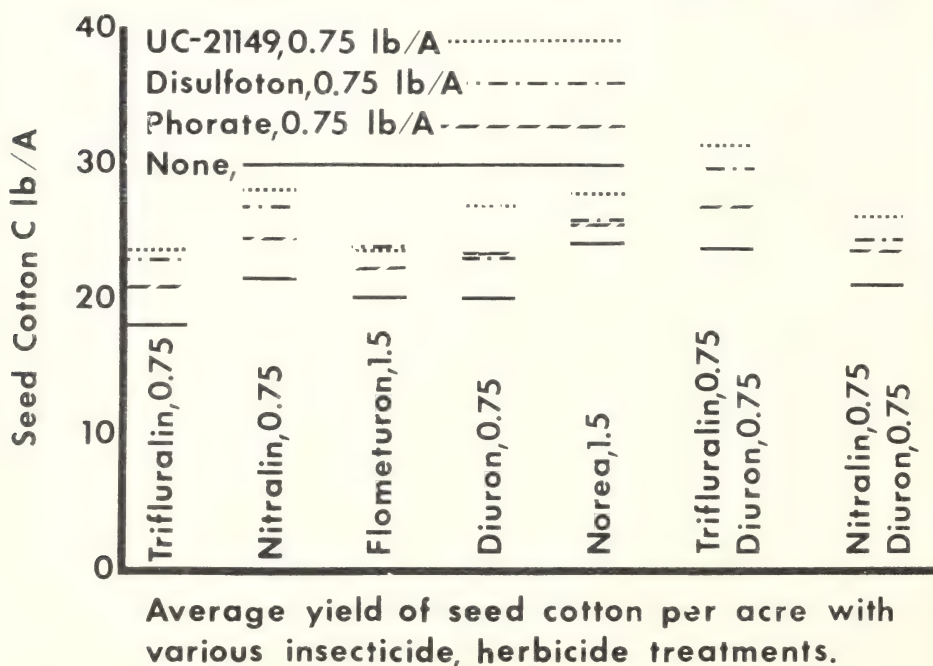
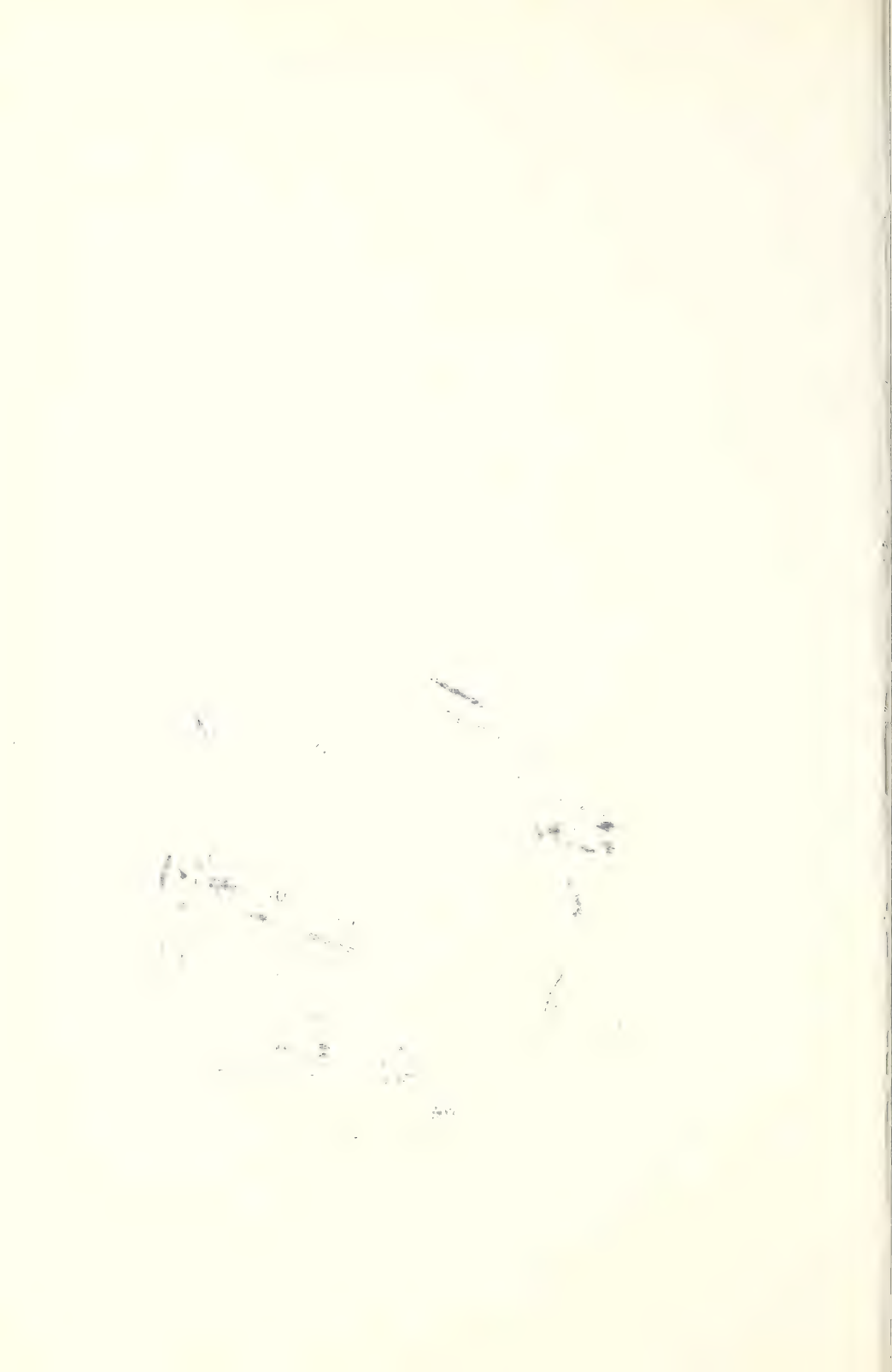
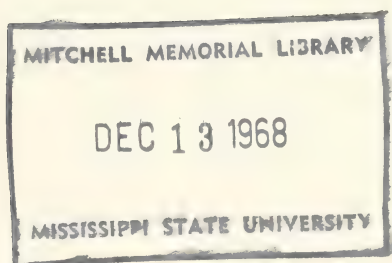


Figure 2. Note high yield from plots treated with UC-21149. In this study, thrips count was the variable that best correlated with yield.



**The Effect of
Types and Quality Roughages
On Subsequent Performance of Steers
During the Winter Period**



**MISSISSIPPI STATE UNIVERSITY
AGRICULTURAL EXPERIMENT STATION**

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SUMMARY AND CONCLUSION

In a two-year study, 72 steers were used to evaluate three different winter rations, and to determine what effect the ration had on later summer grazing gain and again after being placed in the feedlot. The three winter rations studied were: (1) soybean straw plus grain and CSM; (2) Coastal Bermuda grass hay plus grain and CSM; and (3) high-energy urea-treated silage (milo and corn).

In both winter phases steer calves fed soybean straw plus grain and CSM gained significantly less than the other two treatment groups. The soybean straw fed steers were also the most inefficient producers and had a higher feed cost per pound of gain. The high-energy urea-treated silage fed steers were the fastest gaining and most efficient producers. Feed cost per pound of gain favored the silage fed steers. Coastal Bermuda hay fed steers had the highest wintering cost of the three treatment rations studied.

Summer gains after the winter period corresponded to what was expected. The steers that gained faster during the winter produced the least gain during the summer. There was no significant difference in rate of gain between the three treatment groups during the summer grazing period; however, the soybean straw fed steers gained at a faster rate, making up some of the gain that was restricted during the winter.

Feedlot gains were little affected by previous winter rations, although the Coastal Bermuda grass hay fed steers during the winter tended to gain less during both trials, while in the feedlot. Efficiency of gain and feed cost per pound of gain favored the soybean straw and high - energy urea - treated silage fed steers with the Coastal Bermuda hay fed steers having the poorest efficiency and highest feed cost per pound of gain.

Carcasses information collected only on the steers in the second trial indicated no significant difference in any of the carcasses traits collected; however, the steers fed silage during the winter produced carcasses with more finish than the other two groups.

Rate of gain for the entire study in both trials, when summarized, showed winter ration made little difference; however, for any one period during the study treatments variation in rate of gain was somewhat variable.

Return per steer (including only the feed and initial steer cost) was greater for the steers fed the high-energy urea-treated silage during the winter, with the least return coming from steers fed the soybean straw.

The Effect of Types and Quality Roughages During the Winter Period on Subsequent Performance of Steers

By WILLIAM A. PUND and PETER G. HOGG¹

Growing and finishing out steers is an important system of beef production for cattlemen of the Delta. Winter rations represent one of the major costs in growing out steers. The most desirable level of wintering depends upon the purpose of animals after winter; whether they go on grass for further growth and then to the feedlot, or go directly to the feedlot for finishing.

The purpose of this study was to evaluate three different types and quality roughages for growing steer calves during the winter and to determine what effect these roughages have on subsequent performance on summer grass and later performance in the feedlot. The study was divided into three phases; winter phase, summer phase, and feedlot phase.

Two trials were conducted over a period of two years. The first trial began December 2, 1965 and concluded December 21, 1966, a total of 378 days. The second trial began December 5, 1966 and concluded January 8, 1968, a total of 398 days.

Materials and Methods

At the beginning of each trial, 36 steer calves were allotted at random by weight and breed into three treatment rations. The rations studied were (1) soybean straw plus 2 lbs. ground shelled corn and 1.5 lbs. cottonseed meal; (2)

Coastal bermudagrass hay plus 2 lbs. ground shelled corn and 1.5 lbs. CSM; and (3) only high-energy urea - treated silage.

The roughage for each ration was common to the area and was produced and harvested by the Experiment Station. The soybean straw, picked up after the soybeans had been combined, was chopped and blown into a wagon with the forage chopper. The Coastal bermudagrass hay was baled from hay plots on the Station. The silage was cut at a height to give a high grain to roughage ratio. At the time of ensiling 10 lbs. urea and 10 lbs. feed grade limestone were added per ton of silage material.

Steers on soybean straw and Coastal bermuda hay rations were fed all the roughage they could eat, plus the 2.0 lbs. grain, and 1.5 lbs. cottonseed meal. No additional grain or protein was fed the steers on the high-energy urea-treated silage ration.

After the steers had been on the winter ration for 112 days, they were placed on summer grazing of Coastal bermudagrass for approximately 150 days, in both trials, and then put in the feedlot and fed high-energy urea-treated milo silage in the first trial and high-energy urea-treated corn silage in the second trial.

Results

Winter: During the course of the study the steers had little or no health problems. Steers fed soybean straw consumed an average of only 6.58 lbs. of the straw daily, which was considerably lower than the 9.16 pounds of Coastal Bermudagrass hay consumed by steers on this roughage. Since steers on the silage

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Appreciation is expressed to Dr. R. W. Rogers, Assistant Professor, Animal Husbandry Department, Mississippi Agricultural Experiment Station, State College, Mississippi for his assistance in collecting carcass information on the experimental animals.

Table 1. Performance data for steers on three rations summarized for two years.

	Initial weight	Final weight	Average gain	Daily gain	Feed/steer per day	Total Dry matter/day	Dry matter /cwt. gain	Feed cost/ lb. gain
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	cents
WINTER:								
Soybean straw	462	531	70	0.62*	10.1	9.18	1723	21.2
Coastal B. hay	459	581	122	1.09	12.7	11.53	1115	16.1
High E. silage	462	598	136	1.22	24.1	10.10	822	9.4
SUMMER:								
Soybean straw	528	653	125	0.87				7.2
Coastal B. hay	581	683	102	0.70				8.8
High E. silage	593	690	98	0.67				9.3
FEEDLOT:								
Soybean straw	654	929	275	2.16	45.3	20.23	1142	13.6
Coastal B. hay	684	935	251	1.91	42.5	20.22	1317	15.4
High E. silage	691	956	265	2.06	43.6	19.51	1151	13.7

*Significantly different from other treatments at the .05 level of probability.

Feed cost: Soybean straw, \$8.00/ton; Coastal Bermuda hay, \$23.95/ton; high-energy urea-treated silage (milo - \$13.28/ton and corn - \$5.75/ton); ground shelled corn, \$1.43/bu.; cottonseed meal, \$4.37/ton; and pasture - \$11.38/acre - 1.25 steers per acre=\$9.10/steer.

received no additional grain or protein, a total dry matter daily consumption per treatment would be a more realistic comparison. Steers fed the soybean straw plus corn and CSM consumed an average of 9.18 lbs. total of dry matter. On the Coastal Bermudagrass hay plus corn and CSM ration steers consumed an average of 11.53 lbs. while those on silage averaged 10.10 lbs. total of dry matter daily.

Rate of gain varied between trials, which was unexplainable since the steers for both trials came from the same herd and the feeds were relatively the same in chemical analysis between trials. The only difference in feeds between trials was the urea-treated corn silage fed in the first trial, and urea-treated milo silage was fed during the second trial, during the winter.

Average daily gain was 0.62 for the soybean straw, 1.09 Coastal Bermuda hay and 1.22 high-energy urea-treated silage. In both trials steers fed soybean straw gained significantly less than the other two groups, with no significant difference in rate of gain occurring between the remaining two groups.

Not only did the steers receiving the soybean straw gain significantly less than the other two groups, they also were the most inefficient producer since they required a total of 1723 lbs. dry matter per 100 lbs. gain compared to 1115 lbs. dry matter for the Coastal Bermudagrass hay and 822 lbs. for the silage groups.

This inefficiency in rate of gain on the soybean straw affected the feed cost per pound gain. Based on prices at the time of the study the feed cost per pound gain for the soybean straw fed steer was 21.2c compared to 16.1c for the Coastal Bermuda hay fed steers and 9.4c for the silage fed steers.

When cost of feed for wintering the three groups of steers was considered, the steers fed the high-energy urea-treated

silage were the most economically wintered, \$12.15 per steer compared to \$16.01 for soybean straw and \$19.18 for Coastal Bermudagrass hay.

Summer: It is apparent from both trials that steers making the least gain during the winter made the most gain during the summer.

The soybean straw fed steers gained more while on summer grazing; 0.87 lbs. per day compared to 0.70 lbs. for the Coastal Bermudagrass hay group, and 0.67 lbs. for the silage fed group. However, this increase in gain was not significant.

When grazing cost per pound of gain was based on permanent pasture establishment and maintenance cost per acre, and with a carrying capacity of 1.25 steers per acre, the soybean straw fed steers were the most economical. Pasture cost per pound of gain ranged from a high of 9.3c for the steers fed silage to a low of 7.2c for the group fed soybean straw with 8.8c per pound of gain for the Coastal Bermudagrass hay fed group.

Feedlot: Rate of gain of the steers varied considerably between trials. In the first trial the steers were fed high-energy urea-treated milo silage. Therefore, rate of gain was consistently low for all three treatments. Milo harvested as high-energy silage has not produced gains equal to that of corn silage in feeding trials conducted at the Delta Experiment Station.

During the feedlot phase of the second trial, high-energy urea-treated corn silage was fed and rate of gain was improved over the first trial by 1.20 lbs. per day. Average daily gain for the combined three treatment groups during the feedlot phase was 1.44 lbs. per day for the first trial, and 2.64 lbs. per day for the second trial. These low gains during the first trial affected the efficiency and cost of gain very much.

Rate of gain between treatment groups of both trials did correspond. The group

fed Coastal Bermudagrass hay gained the least.

The average daily gain between groups was not significantly affected by the previous winter ration. However, the steers fed the soybean straw gained at a faster rate during the feedlot, or finishing phase. The average daily gain was 2.16 lbs. per day for the soybean straw fed steers; 1.91 for the Coastal Bermuda hay and 2.06 lbs. for the silage. Soybean straw was consumed at the rate of 45.3 lbs. of feed daily compared to 42.5 lbs. for Coastal Bermuda hay, and 43.6 lbs. for silage.

Steers that received Coastal Bermuda hay during the winter not only gained at a slower rate, but were also the most inefficient producers since they required a total of 2803 lbs. of feed per 100 lbs. gain, compared with 2474 for the silage and 2460 pounds for soybean straw fed groups. Cost per pound of gain in the feedlot was affected by the winter ration fed to the steers, but not significantly. Feed cost per pound of gain ranged for a high of 15.4c for the group wintered on Coastal Bermuda hay to a low of 13.6c for the soybean straw fed group, and with a 13.7c for the steers fed the silage during the winter.

The first trial did not produce finished steers; they were sold as feeders, averaging approximately 825 lbs. In the sec-

ond trial the steers finished out at approximately 1045 lbs. and were sold on grade and yield.

Previous winter ration did not significantly affect any of the carcass characteristic; however, the high-energy urea-treated silage steers were carrying more finish. Dressing percentage were low for all three treatments, compared to steers that are fed on dry or part-dry ration. The average final grades of the carcasses were low choice to average choice.

No significant difference was found between the treatment groups, although the steers fed silage during the winter graded higher than the other two groups and the soybean straw fed group graded the lowest.

Rate of gain was not significantly affected by winter ration when the entire study period was considered. Average daily gain for the steers fed soybean straw was 1.20 lbs. The steers fed Coastal Bermuda hay gained 1.23 lbs. per day, while the silage fed steers averaged 1.27 lbs. per day.

A considerably larger return was made on the steers fed the silage during the winter phase of the study than the other two groups. This group averaged \$75.39 as compared to \$61.86 for the Coastal Bermuda hay group, and \$52.34 for the soybean straw groups.

Table 2: Carcass data on steers from trial two

	Soybean straw	Coastal Bermuda hay	High- energy silage
Carcass weight, lbs. ¹	571	588	615
Dressing percent	56.1	56.3	56.9
Conformation score ²	12.58	12.16	13.00
Marbling score ³	5.25	5.83	6.25
Grade ⁴	12.00	12.58	12.83
Yield grade ⁵	2.50	2.58	2.83

¹less 2% shrink of hot carcass weight.²10=average good, 11=high good, 12=low choice, 13=average choice.³3=trace, 4=slight, 5=small, 6=modest, 7=moderate, 8=slightly abundant.⁴10=average good, 11=high good, 12=low choice, 13=average choice.⁵3=50.0 - 47.7 percent - 2=52.3 - 50.0 percent.Table 3. The effect of winter ration on the production of steers.
(Two-year average)

Treatments	Soybean straw	Coastal Bermuda straw	High- energy silage
Number steers per lot	12	12	12
Winter as calves:			
Initial weight, lbs.	462	459	462
Final weight, lbs.	531	581	598
Gain, lbs.	70	122	136
Feed cost ¹	16.01	19.18	12.15
Steer cost ²	111.08	111.08	111.08
Summer as yearling:			
Initial weight, lbs.	528	581	593
Final weight, lbs.	653	683	690
Gain, lbs.	125	102	98
Gain to date, lbs. ³	195	225	234
Feed cost	9.10	9.10	9.10
Finished as two-year-old:			
Initial weight, lbs.	654	684	691
Final weight, lbs.	929	935	956
Gain, lbs.	275	251	265
Gain to date, lbs. ³	467	486	494
Avg. daily gain to date, lbs. ³	1.20	1.23	1.27
Feed cost ¹	24.35	22.89	23.20
Selling price/cwt. ³	23.64	24.29	24.28
Value/steer, 3% shrink	217.88	224.09	230.95
Return/steer to date ⁴	57.34	61.86	75.39

¹Feed prices are shown in feed price table.²Actual price per steer which was the same for all lots.³Gain since the beginning of the test.⁴Return per steer from the beginning of the test when only steer cost and feed cost were considered.



Alfalfa Diseases



Figure 1. Growth of the downy mildew fungus on lower surface (above) and upper surface (below) of two alfalfa leaflets and a leaf. Healthy leaflet at left in each series.

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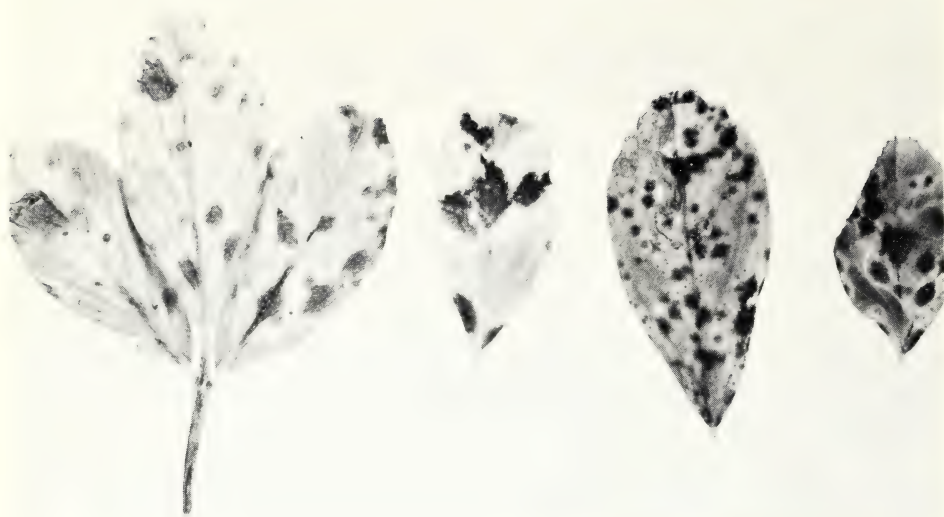


Figure 2. Cercospora leafspot on Lahontan alfalfa leaflets and a leaf.

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ALFALFA DISEASES

By HOWARD W. JOHNSON¹

Diseases are a limiting factor in establishing and maintaining profitable stands of alfalfa in Mississippi. In addition to shortening the productive life of stands, disease organisms that attack the leaves, stems, and roots reduce the yield and quality of the alfalfa hay. No single disease appears to be of outstanding importance in this region. However, the cumulative effect of the numerous disease-producing organisms that attack alfalfa creates a serious problem for alfalfa growers. This situation is intensified by the short period of dormancy, or semi-dormancy, of the crop during the brief, mild winters, since this permits the pathogens to remain active during much of

the year.

To assist technical workers and alfalfa growers in Mississippi in identifying and controlling the diseases, this publication describes and illustrates the symptoms of the more prevalent ones, gives some information on their distribution and seasonal occurrence, and discusses control recommendations briefly. The diseases are classified according to the principal plant part attacked, although no disease is restricted strictly to one plant part in its effects. Damping-off and the vascular wilts, which are characterized by general wilting and death of the entire plant, are discussed under root and crown diseases.

LEAF DISEASES

The leaves of alfalfa are attacked by a series of pathogens throughout the season, ranging from the pepper spot fungus in late winter and early spring to the rust fungus in late fall. These parasites cause premature defoliation, thus reducing the size and quality of the hay crops at each cutting.

Pepper Spot

Pepper spot, caused by the fungus *Leptosphaerulina briosiana* (Poll.) Graham and Luttrell, appears on the alfalfa plants in late February or March in the South. Symptoms are hundreds of small black flecks on both surfaces of the leaf blades and on the petioles. This gives the plants the appearance of having been well peppered and has led to the common name "pepper spot." The spots enlarge slightly as they mature and the infected leaves turn yellow and fall from the plant. Perithecia develop on the dead overwintered leaves in late winter and

the ascospores discharged from these serve as inoculum. The disease is widespread on alfalfa.

Downy Mildew

Downy mildew (*Peronospora trifoliorum* D By.) may cause considerable damage to the first cutting of hay and weaken the plants. Symptoms are light-green leaves at the apex of the stem and a grayish-white, mold-like growth on both surfaces of the leaves (Figure 1). The fungus lives from year to year as oospores which form in the dead tissues and as perennial mycelium in the crown buds. The disease is widely distributed on alfalfa.

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Ascochyta Leafspot

Ascochyta leafspot (*Ascochyta imperfecta* Pk.) develops during the cold, wet conditions of early spring. Dark spots that are variable in size and shape develop on the leaflets, which finally turn yellow and fall off. The first cutting may suffer considerable damage. The same fungus causes dark brown to black lesions up to 3 inches in length on stems and petioles. This stage of the disease is known as spring black stem. The organism overwinters in dead alfalfa stems and the spores produced in pycnidia on the stem lesions in the spring serve as inoculum. The disease occurs in all alfalfa-growing regions of the United States.

Cercospora Leafspot

Cercospora leafspot (*Cercospora medicaginis* Ell. & Ev.) develops during warm, moist weather and reduces the value of the summer cuttings of alfalfa. The spots are roughly circular and dark brown to black in color (Figure 2). They appear ashy-gray during moist weather, when spores are produced in abundance on the lesions. The same fungus causes dark, elongated lesions on the stems and petioles (Figure 3). This stage of the disease is known as summer black stem. Severely diseased leaves fall off. The lesions are conspicuous when the plants are in flower and cutting in an early bloom stage should save some of the leaves from falling.

Stemphylium Leafspot

Stemphylium leafspot (*Stemphylium botryosum* Wallr.) develops on the summer growth of alfalfa during warm, moist periods. The lesions on the leaflets show concentric zones of light and dark brown tissues. Older lesions may appear sooty from the abundant production of large, muriform spores. This leafspot appears to be less prevalent than those discussed above but is responsible for some defoliation in many years.

Common Leafspot

Common leafspot (*Pseudopeziza medicaginis* (Lib.) Sacc.) occurs as small, circular brown spots on the leaflets. They usually do not discolor the surrounding leaf tissues. When the spots are fully developed (about 1/16 inch in diameter), a small dark-brown to black raised disk develops on each. The spores that spread the disease are produced in the raised disks that are called apothecia. This disease is of minor economic importance in Mississippi in comparison to the other alfalfa leafspots discussed above.

Alfalfa Rust

Rust, caused by the fungus *Uromyces striatus* Schroet. var. *medicaginis* (Pass.) Arth., occurs on leaves of alfalfa plants during summer and fall. The disease is characterized by reddish-brown masses



Figure 3. *Cercospora* lesions on stems and petioles (left) and on a shoot tip (right) of Lahontan alfalfa.



Figure 4. Rust pustules on the lower surface of alfalfa leaves and a non-rusted leaf (lower left).

of fungus spores that rupture the epidermis of the leaves (Figure 4). When abundant, the rust pustules cause the leaves to shrivel and fall, thus reducing the size and quality of the hay crop. The alfalfa stems may become infected when the interval between cuttings is lengthened, as in making a seed crop. The disease is widely distributed in the southern United States.

Alfalfa Mosaic

Mosaic is a virus disease characterized

by yellow and green mottling of the alfalfa leaves. It becomes evident during the cool weather of spring and fall when the stunted, mottled plants may be observed scattered throughout the alfalfa fields. During the warmer summer months, very few symptoms can be seen. The pea aphid spreads the virus from plant to plant in the field. The disease is not of major importance in Mississippi, but its widespread occurrence and the stunting of growth that occurs cause some loss in yield each season.

STEM DISEASES

The stems of alfalfa plants are attacked by a series of pathogens throughout the season, starting with stem rot in early spring. Some of these organisms cause leafspots as well as stem lesions

and some are able to invade and rot the crown of the plant as well as the stem. The losses they cause are probably greater than those caused by the foliar parasites discussed above.

Stem Rot

Stem rot (*Sclerotinia trifoliorum* Eriks.) is evident in early spring as a rotting of the stem bases and crown branches near the soil line. The fungus causes death of these tissues and wilting of the tops. Abundant fungus mycelium develops on the surface of the lesions and this appears as a white, cottony mat during moist weather. Black, hard, irregularly-shaped sclerotia are formed in the white mat (Figure 5). These remain dormant during the summer and germinate in the cool, moist weather of autumn by producing vegetative mycelium or small, stalked, saucer-shaped apothecia which emerge to the soil surface (Figure 6). The apothecia produce large numbers of ascospores that are discharg-

ed into the air and reproduce the fungus. The disease is widely distributed and is of economic importance in some seasons.

Southern Anthracnose

Southern anthracnose (*Colletotrichum trifolii* Bain) occurs in early summer as lesions on the alfalfa stems and petioles (Figure 7). Spore-producing bodies (acervuli) develop in the bleached centers of the stem lesions. Spores from these cause new infections. The girdling of the stems and petioles causes wilting and browning of the tissues above the girdled areas. This reduces the size and quality of the hay crop. Under favorable conditions for disease development, the fungus may invade the crown and the taproot, thus weakening or killing the plants. The



Figure 5. Segments from basal region of Oklahoma Common alfalfa stems showing lesions covered by the white mycelium and the black sclerotia of the stem rot fungus.



Figure 6. Germinating sclerotia of the stem rot fungus dug from field soil in December.

disease is common in the Southern States on both alfalfa and clovers.

areas are predominately tan in color. The attacked tissues are killed causing the

Sclerotial Blight

Sclerotial blight (*Sclerotium rolfsii* Sacc.) is evident in the summer when the fungus attacks the stem bases and crown branches of the alfalfa plants. The plant tissues above bleach to a tan color and die (Figure 8). The small, light-brown, spherical sclerotia of the fungus are found on the stems and crown and on mycelial mats that form on the soil surface. They look like mustard seeds. The fungus is widespread in silty and sandy soils in the Southern States and it is on these soil types that the more severe losses occur. The common name "southern blight" is applied to this disease, since it occurs primarily in the South. The fungus attacks a wide range of host plants, including grasses, and causes loss of stand.

Rhizoctonia Stem Canker

Rhizoctonia stem canker (*Rhizoctonia solani* Kuehn) has been observed on alfalfa at Stoneville, Miss., following flood irrigation (Figure 9). The cankered

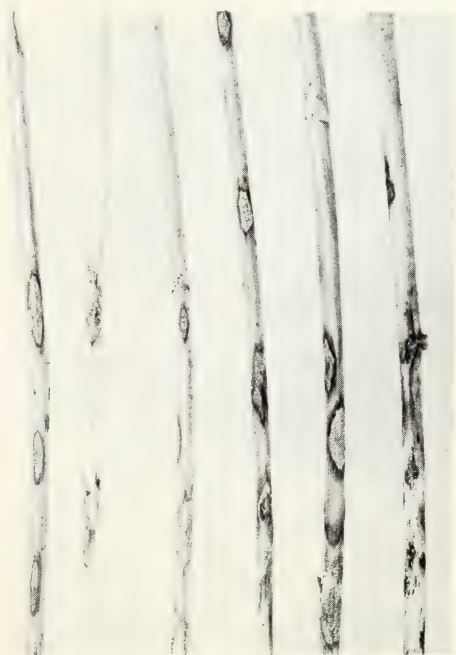


Figure 7. Anthracnose lesions with bleached centers and dark margins on alfalfa stems.



Figure 8. Portion of an alfalfa nursery row showing dead and dying plants that resulted from an attack by the sclerotial blight fungus.

leaves and stem tips to yellow, wilt, and die. The fungus is widespread in southern soils where it attacks cotton and many other plants. On alfalfa, it causes greater losses as a seedling pathogen and as a crown and root-rotting parasite

than it does by cankering stems. The fungus forms sclerotia that differ from those of the sclerotial blight fungus by being irregular in shape and darker brown in color. They serve to perpetuate the fungus in the soil.

ROOT AND CROWN DISEASES

Numerous pathogens attack the root and crown of the alfalfa plant throughout its life, starting with damping-off of young seedlings and ending with rotting of the crown and taproot of mature plants in old stands. The losses caused thus range from those due to difficulty in establishing a stand to those due to prema-

ture thinning of old stands. In either case, the grower is faced with the cost of reseeding the field.

Damping-Off

Alfalfa seedlings may be attacked by several soil fungi, if environmental con-

ditions are favorable for infection after seeding. These cause death of the seedlings, either before or after emergence from the soil. A species of **Phytophthora** isolated from a diseased alfalfa seedling at Stoneville, Miss., caused a severe killing of alfalfa seedlings when seeds were planted in steamed soil artificially infested with the fungus (Figure 10). A

Pythium sp. caused a similar amount of killing when tested in this way. These fungi are sometimes called water molds, since the resting spores germinate in wet soil by forming free-swimming zoospores, or vegetative mycelium, that spread the causal organism from plant to plant.

The disease is, therefore, more destructive in a wet, clay soil with poor internal drainage. Other fungi that cause damping-off of alfalfa seedlings are **R. solani** and **Fusarium** spp.

Root and Crown Rots

Several soil-inhabiting fungi cause rotting of the root and crown of mature alfalfa plants, particularly when the plants have been weakened by some type of winter injury or by summer drought. Tap roots of some dying plants of Delta alfalfa dug at Stoneville, Miss., were found to bear black, stromatic masses of fungus tissue externally (Figure 11). When such crowns and tap roots were split open



Figure 9, Lesions on stems of Buffalo alfalfa (left) caused by *Rhizoctonia solani* following flood irrigation of a field at Stoneville, Miss., and a healthy stem (right).

longitudinally, a dark-gray to black internal discoloration was observed (Figure 12). When pieces of the blackened tissue were placed in moist chambers, beaked spore - producing structure (pycnidia) developed and a species of *Botryodiplodia* was isolated in pure culture. The fungus caused a slow, black rot of the tap root of alfalfa seedlings when mycelium was inserted in a slit. The fungus appeared to be a slow-acting parasite. Two other fungi have been isolated from alfalfa roots similarly discolored; i.e. *Mycleptodiscus terrestris* (Gerd.) Ostazeski and *Sclerotium bataticola* Taub. As mentioned above, the fungus causing stem canker (*R. solani*) also attacks and rots the crown and roots of alfalfa. The diseased tissues, in the latter case are dry and dark-brown in color.

Bacterial Wilt

Bacterial wilt, caused by the bacterium *Corynebacterium insidiosum* (Mc. Cull.) H. L. Jens., is seen frequently in the lower poorly-drained portions of fields in northeastern Arkansas and the Missouri bootheel. It is of infrequent occurrence in the Yazoo-Mississippi Delta area.

The first symptom is stunting of the infected plants, noticeable usually as a slow recovery after cutting. Diseased plants have an increased number of smaller diameter stems and the leaflets are smaller and thicker. Yellowing of the leaves soon occurs, followed by wilting during periods of water stress. The tap root shows a yellow-brown discoloration of the outer woody tissue when the bark is peeled off or the root is cut through. In advanced stages, all parts of the wood show a brown color. The bacteria are present in the water-conducting tubes of the roots and stems and are released by the breakdown of the infected tissues. They are distributed in the soil water and gain entrance to new plants through wounds. Plants usually die 5 to 8 months after infection. Resistant varieties are the only practical means of control.

Fusarium Wilt

Fusarium wilt, caused by the fungus *Fusarium oxysporum* Schlecht. f. *medicaginis* (Weimer) Snyder et Hansen, was reported as an alfalfa disease for the first time in 1927 from Mississippi, where



Figure 10. Thin stands of Delta (left) and Buffalo (right) alfalfas obtained when seeds planted in pots of steamed soil infested with a *Phytophthora* sp. The pots in the center (front and rear) show the thick stands obtained when the two varieties were seeded at the same rate in non-infested steamed soil.



Figure 11. Black, stromatic masses of fungus tissue on the exterior of alfalfa roots from which a *Botryodiplodia* sp. was isolated (right) and the root from a healthy plant (left).

it was recognized as a factor in thinning out stands. The first symptom of the disease is a rapid wilting of the stems on one side of the plant during the hot part of the day, or when the soil becomes too dry. This is followed by bleaching of the affected tissues and the development of a pink color in the basal leaves. The

woody cylinder of the root and crown branches shows a browning of the vascular bundles. The vascular discoloration is restricted to one side of the root, when only one stem or a part of the top is killed. Fusarium wilt resembles bacterial wilt to some extent. There are no resistant varieties.

DISEASE CONTROL

Direct control measures, such as spraying and dusting, have only limited application in controlling alfalfa diseases. In most cases, control must be sought through the development of disease-resistant varieties by selection or hybridization. Two such varieties adapted to the Lower Mississippi Valley States are Cherokee and Delta.

Cherokee was developed jointly by the North Carolina Agricultural Experiment Station and the Crops Research Divi-

sion of the U.S. Department of Agriculture. Released in 1961, it is the end product of 7 cycles of recurrent selection and is tolerant to leafhopper yellowing, alfalfa rust, crown and stem rots, and certain leaf spot diseases. It has yielded well in tests in the Lower Mississippi Valley States.

Delta was developed jointly by the Mississippi Agricultural Experiment Station and the Crops Research Division of the U.S. Department of Agriculture. Releas-



Figure 12. Alfalfa crown and tap root split open to show the dark-gray to black internal discoloration from which a *Botryodiplodia* sp. was isolated at Stoneville, Miss.

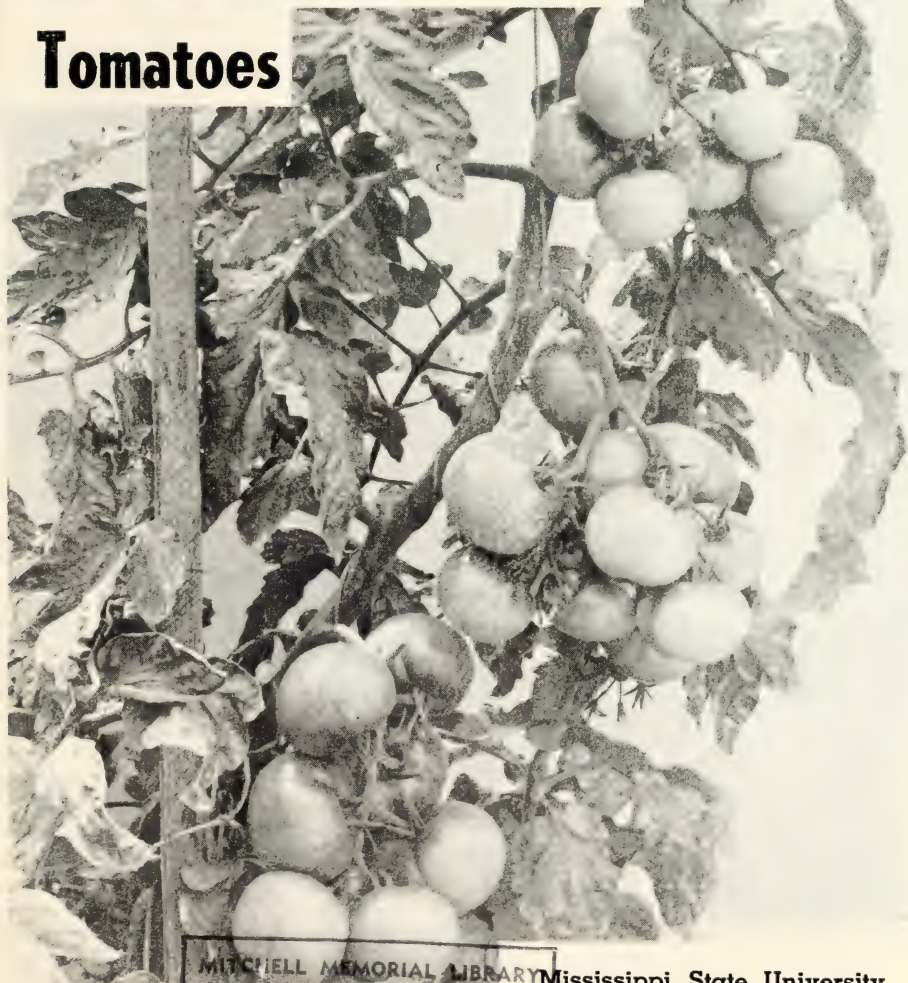
ed in 1965, it is the end product of work started in 1948 when outstanding plants were selected from old alfalfa fields in the Yazoo-Mississippi Delta. Maternal line selection was employed in developing the variety from plants of Dakota 12 alfalfa selected from an old field on the Brown farm near Leland, Miss. Dakota 12 had been grown continuously on this farm for more than 20 years and through 3 or 4 seed generations. Delta persists well on heavy clay soils due to its tolerance to root and crown rots. Like Cherokee, it has yielded well in tests in the Lower Mississippi Valley States.

Where bacterial wilt has become a problem in fields in the region, a wilt-resistant variety such as Buffalo or Cody should be grown.

Modifying cultural practices to control diseases has only limited application in the case of alfalfa. Cutting early before leaf drop increases the yield and quality of the hay crop in the case of some leaf spots. Treating the alfalfa seeds with a fungicide before planting has been tested at Stoneville, Miss., and failed to improve the stand obtained or to increase the yield of hay.

A Study of Four Methods of

Obtaining Fruit Set Of Plastic Greenhouse Tomatoes



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Conclusions

Plants growing in a greenhouse are not subjected to the various wind movements that plants growing in the open experience. This lack of plant movement in conjunction with some other adverse factor may limit pollination and fruit-set in tomatoes. The results of these tests show that greenhouse tomatoes require some special aid in the process of pollination and fruit-set.

The application of a hormone spray gave slight improvement in total yield of fruit over the control.

The use of a mechanical vibrator was the most effective individual technique employed and is recommended to all greenhouse tomato growers.

Under prolonged cool and cloudy weather conditions the combination of the mechanical vibrator and the hormone spray is recommended for more complete fruit-set and slightly better yields.

Figure 4. ON THE COVER: This plant demonstrates the set of fruit obtained from the vibrator plus hormone treatment. The open flowers were vibrated three times each week and sprayed with a hormone when cold cloudy periods prevailed for two days or longer.

A STUDY OF FOUR METHODS OF OBTAINING FRUIT SET OF PLASTIC GREENHOUSE TOMATOES

By E. L. MOORE¹

A frequent problem encountered in the production of greenhouse tomatoes is poor fruit-set. Widespread use of plastic greenhouses has brought this problem into new focus. Several environmental factors influence fruit-set with the two main causes probably being adverse temperature and low light intensity.

The Department of Horticulture of the Mississippi Agricultural Experiment Station has for the past several years studied methods of improving fruit-set and yield of greenhouse tomatoes. These tests have been conducted on both fall and spring crops in the greenhouse. Most of the work has been with the greenhouse forcing variety 'Tuckcross O'. Limited work on other varieties gave similar results.

The cultural practices used by commercial growers were followed as nearly as practical throughout the study. Seeding, potting and transplanting dates varied from year to year but, in general, the

seed were planted about July 15 for the fall crop and December 1 for the spring crop. The seedlings were transplanted to pots at the first permanent leaf stage (Figure 1) and to greenhouse ground beds about the first week of September for the fall and the first week of February for the spring crop. (Figure 2).

Before a crop was set in the greenhouse, the ground beds were spaded and a base fertilizer application was incorporated into the top 6-8" of soil. The fertilizers consisted of 10 pounds each of nitrate of potash and diammonium phosphate per 1000 square feet of ground bed.

When the seedlings were transplanted to the greenhouse beds, each plant received one pint of a starter solution which was prepared by dissolving three pounds of each of the above fertilizer materials in 100 gallons of water. Additional fertilizer applications were made

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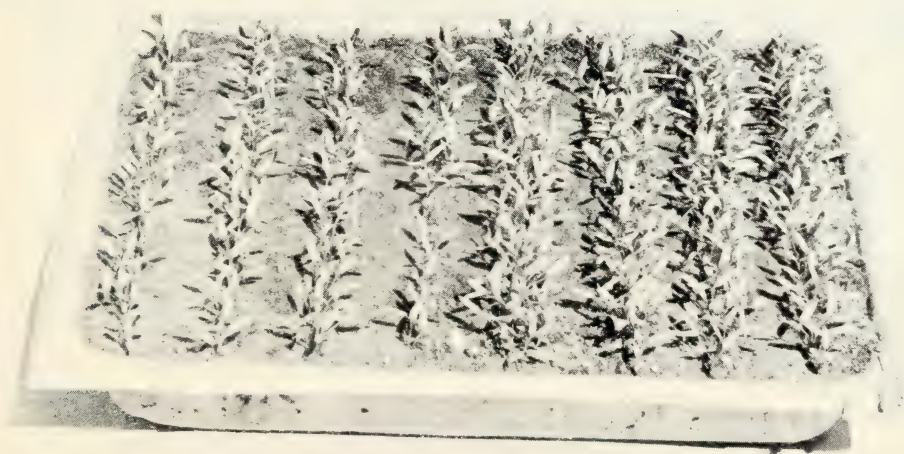


Figure 1. A seed flat of tomato seedlings at the first permanent leaf stage and ready to be transplanted to pots.

Four Treatments

As soon as the young seedlings began to flower, one of four treatments was initiated and continued until the plants reached the 7th to 8th cluster stage. The treatments were (1) a control, (2) a hormone spray, (3) a mechanical vibration of the flower cluster, and (4) a combination of the hormone and vibration treatments.

In the control, no special effort was made to facilitate pollination. The plants were pruned and tied as needed thus being subjected to occasional movement by the laborers. These necessary cultural operations may have aided fruit-set.

The hormone spray consisted of an aqueous solution containing 30 ppm B-Naphthoxyacetic acid² applied three times each week to all clusters having open flowers. This treatment was applied on a time schedule without regard to the prevailing weather conditions. In the mechanical vibration treatment, each flower cluster with open flowers was vibrated with an electrical vibrator three times each week.

In the vibration plus hormone treatment, each flower cluster with open flowers was vibrated three times each week and during prolonged periods (two or more days) of cold, cloudy weather each open flower cluster was sprayed with a solution containing 30 ppm B $\frac{1}{2}$ Naphthoxyacetic acid. The spray was applied in late afternoon and continued on alternate days as long as the cloudy weather prevailed.

Each of the four treatments was applied to five plants in each of five replicates of a randomized block design.

Yields by Treatment

The yield data presented in Table 1 show that the response to the various treatments was consistent from season to



Figure 2. A potted tomato seedling at about maximum size for transplanting to ground beds in the greenhouse.

on the basis of soil tests during the growing season. In general, one and one-half pounds of nitrate of potash and of diammonium phosphate were applied at two to four week intervals per 1000 square feet.

The plants were sprayed with an insecticide and a fungicide in accordance with recommended practices. Water was applied as needed and weeds were controlled by hand hoeing. The plants were pruned to a single stem and supported by binder twine suspended from an overhead wire. The fruit were harvested in the 'pink' stage of maturity.

²The B-Naphthoxyacetic acid used in these studies was purchased under the commercial trade name of Blossom-set.

season and from year to year. The plants of the control averaged 4.3 pounds of fruit per plant.

The application of the hormone increased the average yield 2.3 pounds per plant. Hormone sprays have been highly effective in obtaining a good set of fruit on the first or second cluster of garden tomatoes during cool periods in early spring, but continued use of such materials has not been successful in increasing total yields of either greenhouse or outdoor tomatoes. The reasoning has been that as the spring season progressed, the temperature warmed and the outdoor tomatoes set fruit naturally.

It has been observed in the greenhouse that the application of a hormone spray gave very good results on some occasions but on other occasions the spray was harmful. It was found that harmful effects occurred invariably when the temperature of the greenhouse exceeded 80° F within a few hours after the application of the spray. Bright sunlight was also associated with the ill effects. Since temperatures in the greenhouse exceeded 80° F only on bright sunny days, it is unknown which of the two, temperature or light intensity, was directly involved. Very good fruit-set was observed when relatively mild greenhouse tem-

peratures and cloudy conditions prevailed for several hours following the hormone spray application.

The use of a mechanical vibrator doubled the yield of tomatoes over the control (Figure 3). It produced average yields that were significantly better than the hormone treatment. The fruit obtained from this treatment were very attractive and had more the appearance of field grown tomatoes than those of the control or the hormone treatment. This method of obtaining fruit-set of plastic greenhouse tomatoes has been very successful in commercial operations. It has been observed, however, that under prolonged periods of cool, cloudy weather that this method fails to give complete fruit-set. Under some conditions pollination is incomplete even with the aid of a vibrator.

The vibration plus hormone treatment was designed to combine the good features of both the vibrator and the hormone. This consistently high fruit-set of successive clusters for this treatment is shown in Figure 4. The vibration treatment was applied three times each week. The application of the hormone was somewhat of an arbitrary decision based on the prevailing and predicted weather conditions. The number of applications

Table 1. Effect of fruit-setting techniques on yield of plastic greenhouse tomatoes.

	<u>Control</u>		<u>Hormone</u>		<u>Vibrator</u>		<u>Vibrator + Hormone</u>	
Season	Spring Fall		Spring Fall		Spring Fall		Spring Fall	
	Pounds of fruit per plant							
1959		6.5		7.5		11.0		11.6
1960	5.2	4.7	6.0	7.4	9.1	8.8	9.4	8.9
1961	3.8	3.6	6.2	5.9	9.4	8.3	10.3	9.6
1962	4.1	4.1	7.1	5.8	9.2	7.9	10.7	9.8
1963	3.7	4.4	6.1	5.9	8.8	8.1	8.4	9.7
1964	4.3	3.9	7.8	6.4	8.9	7.6	10.2	9.4
1965	3.9	4.2	7.0	6.7	9.1	8.4	10.7	8.8
Average	4.2	4.5	6.7	6.5	9.1	8.6	10.0	9.7
Average Spring & Fall	4.3		6.6		8.8		9.8	

LSD @ .05 between treatments is 0.88 for spring crop, 0.96 for fall crop and 0.78 for the combined averages of the spring and fall crops.

LSD @ .01 is 1.37 for spring crop, 1.45 for fall crop and 1.31 for the combined averages of the spring and fall crops.

Table 2. Effect of variety and fruit-setting techniques on yield of plastic greenhouse tomatoes—Average of fall crop of 1965 and spring crop of 1966—State College.

Variety	Hormone		Vibrator		Vibrator + Hormone		Varietal Average	
	lbs./ plt.	lbs./ frt.	lbs./ plt.	lbs./ frt.	lbs. plt.	lbs./ frt.	lbs./ plt.	lbs./ frt.
Tuckcross 0	7.2	.272	8.9	.309	10.4	.318	8.8	.30
Missouri Hybrid 390	6.9	.296	8.6	.352	9.4	.378	8.3	.34
Missouri Hybrid 440	6.2	.313	8.5	.331	9.2	.336	8.0	.33
Missouri Hybrid 375	6.8	.306	8.2	.389	9.1	.408	8.0	.37
Tuckcross M	7.0	.278	8.2	.313	8.7	.309	7.9	.30
Missouri Hybrid 443	6.9	.329	7.9	.341	8.8	.339	7.9	.34
Missouri Hybrid 437	6.6	.310	8.3	.326	8.9	.329	7.9	.32
Tuckcross V	6.8	.283	7.8	.303	8.6	.317	7.7	.30
Tuckcross K	6.6	.291	7.3	.327	8.4	.321	7.4	.31
Ohio WR 7	6.4	.308	7.2	.321	8.4	.319	7.3	.32
P-32 (Pioneer)	6.1	.32	6.8	.337	7.4	.349	6.8	.34
Treatment Average	6.7	.306	8.0	.332	8.8	.338		

varied from season to season and from year to year. The hormone was applied when it appeared that weather conditions would inhibit fruit-set on the plants that were receiving a vibrator treatment thrice each week. The combination of the two fruit-setting techniques increased the average yields one pound per plant as compared to the vibrator treatment.

The vibrator, the spray and the combination of the two were tested on several varieties of greenhouse tomatoes as shown in Table 2. These tests were conducted on a fall and spring crop. Each treatment contained 10 plants in each of two replicates.

Response by Varieties

There were slight differences in marketable yield among the varieties, with Tuckcross O making the highest. This variety has consistently yielded well in greenhouse tests at State College and in commercial greenhouse production. An objection to the variety is the small fruit size. It tends to set fruit well and when very liberal applications of fertilizers are made, Tuckcross O produces very attractive fruit that average about 0.3 lbs. each. Table 2³.

The response of the several varieties to the fruit-setting techniques was similar. The effect of the various techniques

on yield followed the same pattern as in the previous tests.

It is imperative that greenhouse tomato growers recognize that the use of these fruit-setting devices is no substitute for good greenhouse management. Many factors affect fruit-set of tomatoes. Among them, temperature and light are probably least understood by new growers.

Effect of Temperature

Tomatoes are very sensitive to temperature conditions during the fruit-setting period and either too high or too low temperatures result in poor fruit-set. At night, the temperature must be kept between 58° and 68° for normal fruit-set of most of the greenhouse forcing varieties. If the temperature is slightly below or above this range for only one night, the damage will be negligible. If it is either below or above 58°-68°F range for four consecutive nights, all the flowers of a cluster will drop. This loss is equivalent to 1-1½ pounds of tomatoes per plant. Adverse temperatures for two or three nights induce proportionate loss.

³A new varietal release, Tuckcross 520, has outyielded Tuckcross 0 in recent comparative tests. The fruit of Tuckcross 520 are large and the plant resists certain strains of *Cladsporium* leaf mold known to be present in most of North Mississippi. It is highly recommended in these areas.



Figure 3. The center plant demonstrates the set of fruit obtained when the open flower clusters were vibrated three times each week. The plant on either side represents the control.

ses. The thermostat should be set so the heat will come on when the temperature at the level of the open flowers drops to about 61°. Most thermostats will then shut the heat off by the time the temperature rises to 65°F.

On cloudy days the greenhouse temperature should range from 60° to 75°F. The practice of heating the greenhouse to temperatures above 65° on cloudy days is discouraged under Mississippi conditions. As a general rule, the extra fuel costs exceed the benefits derived from the higher temperature.

The ideal temperatures for bright sunny days range from 70° to 85°F. Clear day temperatures may reach 90° to 95° in the greenhouse for brief periods without serious damage to fruit-set. However, temperatures in excess of 80° lead to poor color development and increase the amount of cracking in ripening fruit.

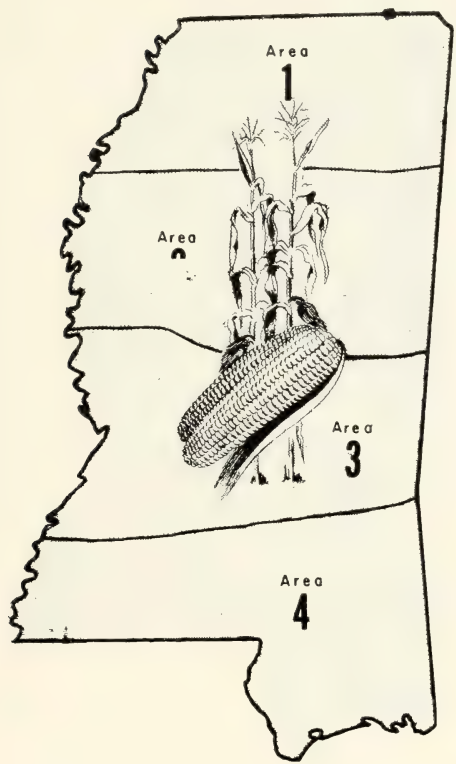
These day time temperatures can be best maintained by having a 2-stage ventilating system. The first stage should come on when the temperature in the greenhouse rises to 70° and should consist of limited ventilation. The second stage should come on between 75° and 80° and be capable of exchanging the air within the greenhouse in one or two minutes.

Effect of Light

Although the naturally prevailing light in Mississippi is adequate most of the time in well constructed greenhouses, there are prolonged cloudy periods when the light intensity is too low for normal fruit-set. Research to date indicates that it is not economically feasible to supply artificial lighting for tomato production. Some other corrective measure such as fruit-setting chemicals must be used during low light intensity periods.

Mississippi Hybrid Corn

Performance Tests, 1968



Mississippi State University
AGRICULTURAL EXPERIMENT STATION

JAMES H. ANDERSON, Director

STATE COLLEGE

MISSISSIPPI

MAY 8 1969

MISSISSIPPI STATE UNIVERSITY

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W. A. Brock, Agronomist, South Mississippi Branch Station, Poplarville.

R. E. Coats, Superintendent, Black Belt Branch Station, Brooksville.

Three of the tests reported were on private farms through the cooperation of M. A. Luter, Tylertown; Charles Huff, Holly Bluff; and R. J. Williams, Clarksdale.

The data on Southwestern corn borer was taken by C. A. Henderson and F. M. Davis, Entomologists, U.S.D.A., State College Mississippi.

MISSISSIPPI HYBRID CORN PERFORMANCE TESTS, 1968

By LLOYD R. NELSON AND GENE E. SCOTT¹

The purpose of the hybrid corn trials is to supply information on the relative performance of the hybrids entered when grown under similar environmental conditions.

Tests were conducted at 13 different locations in Mississippi in 1968. Three tests were not harvested.

The best guide to the desirability of a hybrid is its performance over a period of years at a number of locations. Therefore data are reported for Areas 1 through 4 both for 1968 and for a 3-year average.

Hybrid tests in Area 1 were at Clarksdale, Holly Springs, Pontotoc (Flatwoods and Ridge) and Verona. Tests in Area 2 were at Starkville, Brooksville and Stoneville. In Area 3 the tests were at Raymond, Holly Bluff and Newton. Area 4 tests were at Tylertown and Poplarville.

Early planting was delayed by excessive moisture in Central and Northern Mississippi. The test at Verona was not harvested due to an uneven stand caused by lack of moisture for germination. Lack of moisture during the growing season apparently reduced the yield at Holly Springs and Newton. Yields at Clarksdale, Stoneville, Pontotoc and Raymond were excellent due to adequate growing conditions.

Data from Holly Bluff were discarded because of inconsistencies caused by variability in soil and heavy rains. The hy-

brid test at Tylertown was not harvested due to a poor stand. The test at Poplarville was not harvested due to factors beyond the control of the experiment station. Therefore we have duplicated the 1967 and 1965 through 1967 data for Area 4.

A randomized complete block experimental design with five replications was used at all locations. All experiments were over planted and the seedlings thinned to a desired stand of 12,000 plants per acre. The ears were harvested by hand, weighed, and a moisture sample (grain only) was taken. Grain yields are reported in bushels of ear corn at 15.5% moisture.

Summary

Mississippi continues to be a corn deficient state. Thus, it should be a profitable location to produce corn. Correct cultural practices to maximize yields would include the following:

- Properly select your corn land
- Prepare land in fall where desirable
- Select best hybrid for your farm
- Plant as early as practical for your area
- Select appropriate plant spacing
- Apply correct fertilizer and weed control
- Observe crop during growing season for limiting production factors
- Harvest early.

Area 1

THREE-YEAR SUMMARY PERFORMANCE, 1966-68 (AREA 1)

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture		Earworm		Husk		P.C.W. 4/ Infest- ation %
		Root %	Stalk %			In Grain %	Pene-1/ tration In.	Infest- ation %	Exten-2/ In.	Tight-3/ ness In.		
Miss. 6133 (Exp.)	74.6	1	21	3.9	1.4	15.6		.60	50	3.02	.51	15
Dixie 55	73.4	1	21	4.0	1.3	15.7		.47	55	3.03	.54	13
Pioneer 511A	69.3	1	15	3.6	1.3	15.8		.52	59	2.69	.60	28
McNair 440V	66.8	0	15	3.5	1.2	15.9		.62	70	4.60	.66	35
Funks G-711AA	65.7	3	20	3.8	1.0	16.0		1.00	78	1.99	.79	48
Pioneer 309B	64.8	2	15	3.4	1.1	15.9		.76	63	2.28	.72	35
McNair 340V	64.5	3	14	3.4	1.1	15.8		.87	70	2.26	.76	45
McCurdy M97	59.0	3	21	3.5	1.0	15.2		1.05	84	2.31	.74	38
Embro Jarvis E-1	57.3	2	17	3.1	1.0	15.7		1.19	85	2.69	.62	35
MEAN	66.2	2	18	3.6	1.2	15.7		.90	68	2.76	.66	32

1/ Inches from tip of ear. 2/ Inches beyond tip of ear. 3/ Diameter of silk channel at tip of ear. 4/ Pink Corn Worm.

MISSISSIPPI HYBRID CORN PERFORMANCE TESTS

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AREA 1, RESULTS OF HYBRID TEST AT PONTOTOC RIDGE, PONTOTOC FLATWOODS, HOLLY SPRINGS, CLARKSDALE, 1968.

Pedigree	Acres Yield Bu.	Lodging		Ear		Ears		Moisture		Pene-1/2		Infestation		Extens-2/3		Husk	
		Root Stalk		Ht.		Per		In		In.		%		In.		In.	
		%	%	Ft.	Ft.	No.	No.	%	%	%	%	%	%	%	%	%	%
Miss. 6133 (Exp)	88.7	1	19	4.3		1.6		16.2	100	0.75	58			3.07		0.51	
Pioneer 3185	87.9	0	9	3.7		1.1		17.0	94	1.32	93			2.75		0.62	
Dixie 55	87.1	1	17	4.4		1.4		16.2	100	0.42	55			3.02		0.53	
Funks G795W-1	87.1	0	13	3.8		1.3		16.4	100	0.65	70			2.62		0.60	
McNair 6501	86.1	0	14	4.2		1.6		16.6	99	0.35	60			2.67		0.64	
Coker 548	85.3	0	10	3.5		1.4		16.4	94	0.82	75			2.15		0.76	
Taylor-Evans 6703 (Exp)	84.3	1	12	4.3		1.3		16.6	95	0.40	50			2.72		0.61	
Funks G-711AA	83.7	1	16	4.2		1.2		16.3	97	0.82	73			2.07		0.74	
Miss. 0002 (Exp)	83.4	0	16	4.1		1.4		16.7	98	0.32	33			3.17		0.53	
AKC 66	82.7	1	15	4.1		1.4		16.9	93	0.70	73			2.60		0.63	
Pioneer 511A	82.5	1	14	4.0		1.3		16.6	94	0.22	45			2.80		0.57	
Agrow ATC 450	82.3	1	13	4.0		1.1		17.0	95	0.42	53			3.12		0.56	
Funks G-4877	82.2	0	10	4.0		1.2		17.5	95	0.52	55			3.32		0.54	
Coker 912	82.0	0	15	3.9		1.3		16.2	97	0.65	75			2.40		0.70	
McNair 340V	81.7	1	13	3.7		1.2		16.8	98	0.77	68			2.42		0.75	
McNair 440V	81.7	0	12	3.8		1.4		17.0	97	0.57	68			2.50		0.64	
Pioneer 309B	79.2	0	13	3.7		1.2		16.8	98	0.65	63			2.35		0.66	
Funks G-5757	78.6	1	13	3.5		1.2		16.3	94	1.17	98			2.07		0.82	
Pioneer 309C	78.2	1	13	3.6		1.2		16.5	96	0.85	83			2.25		0.72	
McCurdy M-97	78.0	1	18	3.8		1.2		16.4	97	0.75	75			2.62		0.69	
Funks G-4761	77.7	0	10	3.7		1.1		16.5	95	0.60	68			2.95		0.59	
Dixie 18	77.6	1	17	4.4		1.3		17.0	99	0.70	45			2.82		0.60	
Taylor-Evans 6704 (Exp)	74.0	0	16	4.1		1.4		16.9	93	0.37	38			3.15		0.51	
Embro Jarvis T	73.5	1	15	3.5		1.3		16.4	96	0.65	63			2.47		0.67	
McCurdy 49X3	72.6	0	14	3.7		1.2		16.7	96	1.40	95			1.97		0.88	
Embro Jarvis E-1	59.2	1	19	3.5		1.1		16.7	91	1.00	73			2.45		0.66	
Mean	80.6	1	14	3.9		1.3		16.6	96	0.69	66			2.64		0.65	

L.S.D. (.05) 7.9

1/ Inches from tip of ear. 2/ Inches beyond tip of ear. 3/ Diameter of silk channel at tip of ear.

Area 2

THREE-YEAR SUMMARY PERFORMANCE, 1966-68 (AREA II)

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture In Grain %	Earworm		Husk		P.C.W./4/ Infest- ation %
		Root %	Stalk %				Penet-1/ tration ln.	Infest- ation %	Exten-2/ sion ln.	Tight-3/ ness ln.	
Funks G-4949	87.2	5	12	3.6	1.3	17.8	1.28	84	2.41	.73	99
Funks G-795 W-1	86.7	1	8	3.3	1.2	15.7	1.12	87	2.94	.58	88
Pioneer 511A	86.1	1	10	3.4	1.1	14.2	.98	84	2.97	.56	71
Dixie 18	85.5	1	15	4.5	1.3	15.9	.70	67	3.24	.52	89
McNair 440V	84.5	1	12	3.4	1.4	16.3	.95	85	2.59	.59	88
Funks G-732A	83.6	2	9	3.6	1.1	16.5	1.02	84	2.59	.69	93
Pioneer 309B	83.0	1	18	3.1	1.2	16.0	1.22	90	2.83	.63	89
Miss. 0002 (Exp)	82.7	1	22	4.0	1.2	15.9	.99	79	3.54	.52	94
Pioneer 3048	81.7	1	11	3.6	1.1	16.1	1.16	89	3.03	.58	99
Funks G-711AA	80.9	2	17	3.6	1.0	16.0	1.20	90	2.49	.68	91
Dixie 55	77.4	1	16	3.5	1.2	16.1	1.12	83	3.02	.58	98
Coker 52	76.5	1	6	3.2	1.2	15.9	.75	75	2.75	.56	79
McNair 340V	68.9	1	14	3.0	1.0	16.0	1.14	85	2.63	.66	92
McCurdy M306	67.9	1	16	3.5	1.2	16.4	1.02	82	3.07	.57	80
MEAN	80.9	1.4	13	3.5	1.2	16.1	1.05	83	2.86	.60	89

1/ Inches from tip of ear. 2/ Inches beyond tip of ear. 3/ Diameter of silk channel at tip of ear. 4/ Pink Corn Worm

1/ Inches from tip of ear. 2/ Inches beyond tip of ear. 3/ Diameter of silk channel at tip of ear. 4/ Pink Corn Worm

AREA 2, RESULTS OF HYBRID TEST AT STATE COLLEGE, BROOKSVILLE, STONEVILLE, 1968

Pedigree	Acres Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture		Stand %	Earworm		Husk	
		Root %	Stalk %			In Grain %	Pene- tration In.		Infest- ation %	Exten- sion In.	Tight- ness In.	
Miss. 6133 (Exp)	95.5	1	21	3.7	1.6	17.2	95	1.50	95	3.60	.52	
McNair 6501	94.6	1	13	3.7	1.4	13.6	98	1.07	93	2.50	.63	
Dixie 55	93.3	1	20	3.8	1.4	17.0	94	.97	80	3.07	.53	
Funks G-795W-1	92.5	0	11	3.2	1.2	17.2	97	1.40	93	3.17	.58	
Funks G-5945	89.9	1	9	3.5	1.2	16.8	93	1.17	93	2.77	.62	
Pioneer 3185	89.9	1	8	3.1	1.0	17.0	98	1.72	93	2.80	.62	
Funks G-4761	89.4	0	4	2.8	1.1	16.7	96	1.00	95	2.70	.60	
Pioneer 511A	89.4	0	10	3.2	1.2	16.8	94	1.17	88	3.20	.55	
Pioneer 3048	89.3	1	11	3.6	1.1	17.3	98	1.05	90	3.10	.56	
Pioneer 440V	88.4	0	14	3.2	1.4	17.5	88	1.22	98	2.62	.58	
Miss. 0002 (Exp)	88.3	0	21	4.0	1.3	17.0	95	1.15	83	3.75	.51	
Taylor-Evans 6703 (Exp)	87.8	1	15	4.0	1.1	17.9	94	1.05	95	2.77	.61	
Dixie 18	86.2	1	16	4.6	1.3	17.1	97	.72	70	3.15	.52	
Funks G-732A	86.1	1	11	3.5	1.1	17.3	95	1.22	88	2.67	.69	
Taylor-Evans 6704 (Exp)	84.8	0	22	4.2	1.3	17.4	94	.80	83	3.25	.50	
Coker S48	84.4	1	6	3.0	1.1	16.7	98	1.22	100	2.57	.63	
Pioneer 309C	84.2	0	13	3.1	1.1	17.1	96	1.60	100	2.32	.73	
Funks G-4877	86.1	0	5	3.6	1.0	17.8	100	1.07	95	2.57	.61	
Funks G-711AA	83.0	1	21	3.6	.9	16.9	93	1.37	95	2.47	.68	
Funks G-4949	82.8	1	9	3.6	1.1	17.6	98	.92	73	2.60	.69	
Asgrow ATC 450	82.6	0	7	3.6	1.0	18.1	98	1.05	88	3.07	.64	
Coker 912	82.3	1	11	3.3	1.1	17.0	96	1.20	93	2.77	.63	
Pioneer 309B	80.1	1	20	2.8	1.2	17.1	94	1.30	93	2.85	.68	
Coker 52	79.9	1	9	3.0	1.2	17.0	95	.70	73	2.92	.51	
McCurdy M306	78.3	0	18	3.8	1.2	17.6	91	1.17	88	3.00	.56	
McNair 340V	74.6	1	15	2.9	1.0	17.0	93	1.35	93	2.87	.63	
McCurdy 67X21	71.5	1	16	3.3	1.1	16.4	95	1.30	90	2.75	.61	
Mean	85.7	1	13	3.5	1.2	17.1	95	1.17	90	2.88	.60	

L.S.D. (.05)

1/ Inches from tip of ear.
2/ Inches beyond tip of ear.

3/ Diameter of silk channel at tip of ear.

Area 3

THREE-YEAR SUMMARY PERFORMANCE, 1966-68 (AREA III)

Pedigree	Acre Yield Bu.	Lodging		Ears		Moisture		Earworm		Husk		P.C.W. 4/ Infest- ation %
		Root %	Stalk %	Ear Ht. Ft.	Per Plant No.	In %	Grain %	Pene-1/ tration In.	Infest- ation %	Exten-2/ sion In.	Tight-3/ ness In.	
Pioneer 511A	76.1	1	14	3.6	1.3	14.8		.80	72	2.52	.65	35
Pioneer 3009	75.2	1	10	3.6	1.1	15.2		.82	70	2.98	.58	32
McNair 440V	73.7	1	12	3.6	1.3	14.7		.79	68	2.44	.67	75
Dixie 55	73.6	1	17	4.3	1.3	14.3		.96	71	3.04	.59	27
Pioneer 3048	71.5	0	14	3.8	1.1	14.4		.99	73	3.00	.74	28
Funks G-795 W-1	70.7	1	24	3.3	1.2	13.7		.91	70	2.74	.61	29
Funks G-4949	70.5	1	10	3.6	1.2	14.9		.97	76	2.29	.73	30
Funks G-5945	68.9	1	10	3.8	1.2	15.1		.83	65	2.61	.66	73
Pioneer 309B	68.6	1	19	3.4	1.2	14.4		1.05	79	2.97	.70	76
Miss. 0002 (Exp)	67.8	1	23	4.2	1.3	14.6		.79	63	3.01	.55	32
Funks G-732A	64.6	1	10	4.0	1.1	14.7		.99	76	2.20	.79	37
McCurdy M306	63.7	0	16	4.3	1.2	15.6		.76	61	2.90	.61	33
Dixie 18	61.3	1	23	4.6	1.1	15.8		.78	53	3.25	.51	20
Coker 52	59.7	1	9	3.5	1.2	14.5		.59	55	2.64	.64	29
MEAN	69.0	1	15	3.8	1.2	14.8		.86	68	2.76	.65	40

1/ Inches from tip of ear. 2/ Inches beyond tip of ear. 3/ Diameter of silk channel at tip of ear. 4/ Pink Corn Worm.

MISSISSIPPI HYBRID CORN PERFORMANCE TESTS

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture		Stand %	Earworm		P.C.W.2/ Infest- ation %	Husk	
		Root %	Stalk %			In Grain %	In %		Penet- ration %	In.		Exten- sion In.	Tight- ness In.
Miss. 6133 (Exp)	87.1	0	8	4.3	1.6	15.7		97	0.98		30	3.29	0.55
Pioneer 3009	82.1	0	7	3.7	1.1	17.6		95	0.85		32	2.94	0.61
McNair 440V	81.8	0	12	3.9	1.4	16.9		95	1.03		33	2.41	0.69
Pioneer 511A	81.1	0	10	3.7	1.3	17.7		97	0.80		35	2.32	0.68
Dixie 55	80.7	0	14	4.6	1.4	16.6		99	0.76		27	3.28	0.59
Pioneer 3048	79.2	0	14	4.1	1.2	16.5		96	1.01		28	3.02	0.60
Funks G-4949	78.6	0	14	3.9	1.3	16.5		97	0.93		30	2.81	0.63
Funks G-5945	77.0	1	7	3.9	1.2	17.7		96	1.05		25	2.70	0.69
Funks G-795 W-1	76.8	0	21	3.6	1.2	14.9		91	0.88		29	2.77	0.62
Miss. 0002 (Exp)	76.4	1	16	4.4	1.4	16.6		97	1.05		32	3.24	0.56
Coker S48	76.0	0	14	3.5	1.2	14.6		95	1.51		35	2.09	0.82
McNair 6501	75.9	0	13	4.1	1.4	17.6		96	0.86		42	2.41	0.69
Funks G-732A	75.8	0	7	3.9	1.2	16.8		97	1.10		37	2.47	0.75
Taylor-Evans 6703 (Exp)	75.2	0	18	4.4	1.1	17.8		94	1.04		48	2.70	0.67
Coker 912	74.2	0	15	3.8	1.2	17.1		95	0.88		30	2.25	0.72
Pioneer 309C	73.1	0	14	3.6	1.1	14.9		97	1.40		37	1.79	0.96
Funks G-4877	73.0	0	5	4.1	1.1	19.0		93	0.91		34	3.01	0.61
Funks G-5940	70.8	0	8	4.0	1.1	16.5		97	0.75		28	3.12	0.61
Taylor-Evans 6704 (Exp)	70.2	0	30	4.5	1.3	17.8		93	1.00		29	3.63	0.52
Fla. 200A	68.3	1	10	4.3	1.3	15.2		95	1.05		33	3.13	0.54
Coker 52	68.1	0	12	3.5	1.2	16.9		95	0.70		29	2.75	0.63
Pioneer 309B	68.0	0	26	3.5	1.2	16.2		91	1.08		38	2.49	0.71
McCurdy M306	67.4	0	10	4.3	1.3	18.2		96	1.05		33	3.04	0.58
Dixie 18	67.3	0	15	4.8	1.2	18.4		96	0.94		20	3.48	0.52
McCurdy M307	65.2	0	11	4.5	1.1	18.6		97	0.87		15	3.25	0.57
Funks G-4761	63.4	0	10	3.2	1.0	15.6		93	0.94		34	2.01	0.80
Mean	74.3	0	13	4.0	1.2	16.8		95	0.98		32	2.78	0.65
L.S.D. (.05)	13.8	$\frac{1}{2}$ Inches from tip of ear.		$\frac{3}{4}$ Inches beyond tip of ear.		$\frac{3}{4}$ Diameter of silk channel at tip of ear.							

Area 4

THREE-YEAR SUMMARY PERFORMANCE, 1965-67 (AREA 4)

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture		Earworm		Husk	
		Root %	Stalk %			In Grain %	Penet- ration In.	Infest- ation %	Exten- sion In.	Tight- ness In.	
McCurdy M306	63.2	14	20	3.9	1.3	16.3		0.79	72	2.91	0.65
Coker 71	62.9	18	15	3.5	1.3	16.5		0.48	63	2.86	0.63
Coker 67	62.7	13	23	3.5	1.3	16.7		0.50	61	2.84	0.69
Pioneer 3009	62.3	11	23	3.1	0.9	16.7		0.39	69	3.19	0.62
Dixie 18	61.7	5	27	3.9	1.1	16.5		0.58	69	2.69	0.69
Dixie 55	61.6	10	27	3.8	1.2	14.7		0.67	76	3.13	0.67
Coker 74	59.5	10	12	3.2	1.2	20.9		0.72	54	1.90	0.87
Funks G-740	58.8	9	32	3.7	1.1	16.3		0.59	72	2.84	0.67
Funks G-4949	57.1	16	10	3.4	1.1	16.9		1.30	86	1.48	1.09
Embro Jarvis 260	56.8	10	23	3.6	1.1	16.8		0.54	69	2.95	0.66
Coker 52	55.2	10	22	3.0	1.1	16.1		0.45	70	2.30	0.78
Coker 811A	52.3	10	21	3.3	1.2	17.8		0.42	65	2.97	0.65
Pioneer 3048	52.0	7	31	3.2	1.0	15.7		0.56	71	2.95	0.65
Mean	58.9	11	22	3.5	1.1	16.8		0.61	69	2.69	0.72

1/ Inches from tip of ear. 3/ Inches beyond tip of ear. 4/ Diameter of silk channel at tip of ear.

MISSISSIPPI HYBRID CORN PERFORMANCE TESTS

AREA 4, RESULTS OF HYBRID TEST AT TYLERTOWN, 1967

Pedigree	Acre Yield Bu.	Lodging		Ear Ht. Ft.	Ears Per Plant No.	Moisture In Grain %		Stand %
		Root %	Stalk %					
Coker 71	72.1	0	13	3.6	1.5	14.6		98
Taylor-Evans 6704 (Exp)	72.0	1	32	4.1	1.0	16.8		99
Pioneer 3009	71.0	0	43	3.3	0.9	14.7		94
McCurdy M306	70.0	0	17	4.1	1.3	14.8		97
Coker 74	68.9	0	13	3.3	1.2	15.8		94
Dixie 18	66.3	0	21	4.6	1.1	15.3		101
McCurdy M307	66.0	1	28	4.2	1.1	15.5		100
Greenwood 471	65.9	0	25	3.4	1.2	15.2		97
Miss. 6133 (Exp)	65.0	0	30	3.8	1.5	14.1		99
Coker 67	64.1	0	21	3.6	1.3	13.8		97
Embro 260	63.9	0	20	3.7	1.1	14.5		101
Dixie 55	62.5	0	29	3.7	1.2	14.4		98
Funks G-740	62.3	0	34	3.8	1.0	14.2		99
Coker 811A	61.2	1	18	3.8	1.3	16.3		93
Miss. 0002 (Exp)	60.7	0	18	3.6	1.2	14.2		98
Funks G-4949	60.6	1	13	3.5	1.2	13.9		96
Greenwood 61	59.3	0	15	3.5	1.2	15.0		96
Taylor-Evans 6703 (Exp)	59.3	0	8	3.6	1.1	14.3		100
Dixie 22	58.0	0	25	3.8	1.2	14.0		95
Funks G-5945	57.4	0	27	3.3	1.2	14.1		96
Coker 52	49.1	0	32	3.2	1.0	14.5		98
Pioneer 3048	44.9	0	46	3.1	0.8	13.9		96
Pioneer 3059	37.7	0	58	2.9	0.8	15.4		91
McNair 440V	35.6	0	51	3.3	0.9	14.4		96
Mean	60.6	0	27	3.6	1.1	14.7		97

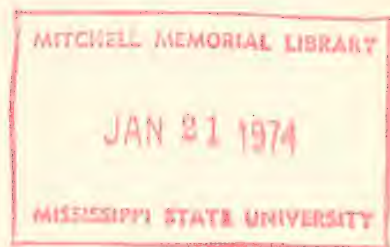
L.S.D. (.05)

11.6

C.V. = 15.2%



Mississippi Cotton Variety Tests Delta And Hill Sections, 1969



**Mississippi State University
AGRICULTURAL EXPERIMENT STATION**

JAMES H. ANDERSON, Director

STATE COLLEGE

MISSISSIPPI

1968 Test Results

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MISSISSIPPI COTTON VARIETY TESTS FOR 1969

IN THE DELTA

By ROBERT R. BRIDGE, WILLIAM R. MEREDITH, JR.,
and JAMES F. CHISM¹

Testing of cotton varieties is essential in areas of cotton production to provide information on the relative values of varieties being offered for sale. Results provide a guide to varieties possessing the best balance of productivity and fiber quality.

Cotton variety trials were conducted by the Delta Branch Experiment Station in 1968 at three locations: the Delta Station at Stoneville, Schaefer Plantation near Yazoo City, and the Mitchner Plantation near Sumner. Variety tests were conducted on two test sites at Stoneville. One test site was on a Bosket very fine sandy loam and another on a Tunica clay type soil.

Current strains of at least 10 varieties were grown at all locations, with 14 varieties being tested in the Stoneville sandy land test and 11 at Sumner and Yazoo City. The test usually planted at Tunica was lost due to heavy rain after planting.

Results are reported at each location for the 1968 tests. Yield data were based on the weight of cotton harvested from the two center rows of four-row plots. Each plot was randomized and replicated seven times. Lint percentage and fiber property determinations were determined from hand picked samples. Fiber properties data were determined by the

U. S. Cotton Fiber Laboratory of the Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture at Knoxville, Tennessee.

Table 1 gives results on a Bosket very fine sandy loam at Stoneville. The test was planted on April 18, about a week earlier than normally. Yields ranged from 852 to 1198 pounds of lint per acre.

A large amount of verticillium wilt was present at this site. The organism that causes verticillium wilt in cotton is a soilborne fungus that penetrates the plant roots and colonizes the entire plant through the vascular system. Damage to the plant is attributed to clogging of the vascular system by wound gums and to secretion of toxic materials by the fungus.

Verticillium wilt not only reduces the yield of cotton, it also damages the quality of fiber as length, strength and grade are adversely affected by the disease. The lint yield was lowered on those varieties having no tolerance to the disease. The presence of this disease may have been partly accountable for the reduced fiber quality in this test.

Table 2 gives the results of the variety test conducted on a Tunica type soil at Stoneville. On this soil cotton was later maturing than on the sandy soil, and the average lint yield was lower, but the fiber length and fiber strength were more desirable. Lint yields ranged from 637 to 1081 pounds per acre. The data shows that fiber quality was better on this site than all other locations.

Results of the Sumner test are presented in Table 3. Lint yields ranged from 868 to 1151 pounds of lint. The highest yielding varieties at Sumner were Deltapine 45A, Stoneville 213, Deltapine 16, and Coker 201. Fusarium wilt and root-knot nematodes at this site greatly re-

¹Plant breeder, Delta Branch Experiment Station, Mississippi Agricultural Experiment Station, Stoneville, Mississippi; Research Geneticist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Stoneville, Mississippi; and Research Associate, Delta Branch Experiment Station, Mississippi Agricultural Experiment Station, Stoneville, Mississippi. This report is based upon results from cooperative research conducted by the Mississippi Agricultural Experiment Station and Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture.

duced the yields of most varieties.

Table 4 gives the results of the test at Yazoo City. The total lint yield ranged 1065 to 1432 pounds of lint per acre, with Stoneville 213 and Stoneville 7A producing the highest yields. Micronaire values showed the fiber to be coarser than that of any other test.

Table 5 gives the average performance of 10 varieties at all test sites. In 1968 the highest yielding varieties were Stoneville 213, Deltapine 16, Deltapine 45A, Stoneville 7A, and Coker 201. Some of the other varieties had better fiber length and strength but averaged about 200 pounds of lint less than the better yielding varieties.

The two-year average (1967-68) in Table 6 shows the same varieties at the top in lint yield.

Table 7 gives the average performance of 5 cotton varieties that were tested over a 4-year period (1965-68). Practically all the cotton acreage in the Mississippi Delta is planted to these varieties. A total of 66 pounds of lint separates these varieties.

This data shows that varieties play an important part in determining the yield and quality of cotton. In a variety selection care should be taken in choosing one that produces the greatest length and highest strength possible without sacrificing significant amounts of yield and performance consistency.

Table 1. Results of 1968 cotton variety test, Stoneville, Mississippi. Bosket very fine sandy loam.

	LINT PER ACRE			Lint percent	Seed index	Boll size grams	FIBER PROPERTIES				
	Total	First pick	Percent first pick				Length		Strength	Elonga- tion	Micro- naire
							2.5%	50%			
Deltapine 16	1198	1031	86	39.6	10.2	6.21	1.10	.51	19.30	8.53	4.71
Stoneville 213	1154	1009	87	39.8	10.6	5.89	1.09	.52	19.04	7.00	4.98
Deltapine 45A	1130	965	85	39.4	10.6	5.86	1.08	.53	18.86	7.27	4.58
Stoneville 7A	1128	968	86	39.5	10.7	5.48	1.09	.52	18.04	5.92	4.67
Deltapine 15A	1060	867	82	40.7	9.6	5.75	1.07	.51	18.45	7.95	4.23
Deltapine Smooth Leaf	1021	885	86	40.0	9.4	5.74	1.07	.51	18.58	7.61	4.82
PD 3-246	1012	862	85	37.0	12.3	6.92	1.16	.55	20.63	5.77	4.15
Hancock	1007	920	91	38.6	11.4	6.87	1.03	.48	16.61	5.92	4.21
Mo 61-470F	997	900	90	36.6	12.8	6.76	1.10	.53	20.42	8.00	4.20
Coker 201	997	893	89	38.5	10.6	6.16	1.10	.51	17.85	5.74	4.42
Stoneville 508	996	844	85	37.9	11.3	6.19	1.14	.56	19.06	7.62	4.17
Acala SJ-1	871	715	82	37.0	12.9	6.84	1.07	.54	23.15	6.60	4.88
Acala 1517D	865	719	83	35.7	12.4	7.35	1.17	.57	22.83	6.26	4.32
Coker 413-68	852	752	88	36.9	10.9	6.26	1.10	.49	18.17	5.84	4.30
C.V.	8.14	8.33		1.62	2.61	3.64	2.17		4.02	4.91	5.09
LSD .05	86	77		1.33	0.62	0.50	0.05		1.64	0.72	0.48
LSD .01	115	102		1.85	0.86	0.69	0.07		2.27	1.01	0.67

Planted: April 18, 1968

Harvested: September 24 and October 16, 1968

Table 2. Results of 1968 Cotton Variety Test-Stoneville, Mississippi. Tunica Clay.

	LINT PER ACRE			Lint percent	Seed index	Boll size grams	FIBER PROPERTIES				
	Total pick	First pick	Percent first pick				Length		Strength grams/tex	Elonga- tion	Micro- naire
							2.5%	50%			
Deltapine 45A	1081	926	85	36.8	11.5	5.72	1.15	.59	20.72	8.13	4.15
Deltapine 16	1056	927	88	36.2	11.1	5.46	1.20	.57	19.23	8.72	4.12
Stoneville 213	1034	914	88	37.1	11.3	5.19	1.16	.55	18.95	7.77	4.62
Mo 61-470F	1005	893	89	35.8	13.9	6.42	1.21	.63	21.39	9.16	4.28
Coker 413-68	1001	866	86	36.6	11.0	5.25	1.21	.58	21.24	6.67	3.99
Stoneville 7A	986	814	82	36.0	11.0	5.07	1.17	.55	19.66	6.34	4.47
Coker 201	974	858	88	38.3	11.5	5.88	1.20	.58	20.20	6.70	4.43
Stoneville 508	884	764	86	35.3	11.9	5.99	1.25	.59	21.50	8.03	3.79
PD 3-246	869	738	85	36.2	13.0	6.39	1.23	.60	22.48	5.77	4.21
Acala SJ-1	637	463	73	34.6	13.8	6.88	1.20	.63	24.84	7.10	4.26
C.V.	8.85	9.12		2.30	4.61	4.12	1.66		2.49	5.02	1.01
LSD .05	89	80		1.89	1.25	0.54	0.05		1.37	0.84	0.30
LSD .01	119	106		2.71	1.80	0.78	0.06		1.70	1.21	0.40

Planted: April 26, 1968

Harvested: October 21 and November 8, 1968

Table 3. Results of 1968 cotton variety test - Summer, Mississippi.

	LINT PER ACRE			Lint percent	Seed index	Boll size grams	FIBER PROPERTIES				
	Total pick	First pick	Percent pick				Length 2.5%	50%	Strength grams/tex	Elonga- tion	Micro- naire
Deltapine 45A	1151	994	86	41.2	10.8	5.61	1.09	19.61	7.52	4.60	
Stoneville 213	1135	982	86	39.9	11.0	5.41	1.10	19.11	7.06	4.96	
Deltapine 16	1111	902	81	40.6	11.1	5.86	1.13	19.13	8.28	4.79	
Coker 201	1111	863	78	40.4	12.2	6.01	1.16	19.21	6.63	4.60	
Stoneville 7A	1068	850	79	40.3	10.8	5.35	1.15	18.52	6.08	4.55	
Deltapine 15A	974	771	79	42.1	10.0	5.46	1.08	19.14	8.46	4.42	
Mo 61-470F	896	726	81	37.6	13.8	5.65	1.16	20.99	8.34	4.33	
PD 3-246	883	631	71	37.8	13.3	6.12	1.23	21.62	5.57	4.27	
Coker 413-68	880	673	76	38.8	11.2	5.02	1.17	20.69	6.40	4.01	
Acala SJ-1	874	646	74	37.2	14.4	6.31	1.18	24.75	6.06	4.48	
Stoneville 508	868	695	80	37.2	12.7	6.07	1.22	20.68	7.60	3.97	
C.V.	13.20	12.98		1.10	3.73	4.41	0.82	3.89	7.00	2.94	
LSD .05	140	110		0.96	0.99	0.56	0.02	1.75	1.10	0.28	
LSD .01	186	146		1.37	1.41	0.80	0.03	2.49	1.57	0.40	

Planted: May 3, 1968

Harvested: October 15 and November 13, 1968

Table 4. Results of 1968 cotton variety test - Yazoo City, Mississippi

	LINT PER ACRE			Lint percent	Seed index	Boll size grams	FIBER PROPERTIES			
	Total pick	First pick	Percent first pick				Length 2.5% 50%	Strength grams/ tex	Elonga- tion	Micro- naire
Stoneville 213	1432	1287	90	40.6	12.0	5.93	1.10	19.12	7.01	5.21
Stoneville 7A	1416	1235	87	39.9	12.0	5.91	1.17	19.30	6.56	4.86
Deltapine 16	1341	1131	84	40.4	12.5	6.45	1.14	20.26	7.95	5.23
Deltapine 15A	1317	1070	81	41.2	11.5	5.92	1.08	19.49	8.66	4.76
Deltapine 45A	1259	1106	88	40.4	12.6	6.07	1.09	19.85	7.78	5.17
Coker 201	1238	1041	84	41.0	12.9	6.28	1.12	20.29	6.15	5.07
Coker 413-68	1188	954	80	38.6	12.5	6.33	1.13	19.19	6.00	4.82
Stoneville 508	1172	966	82	37.5	13.6	6.49	1.18	19.67	6.41	4.54
Mo 61-470F	1110	882	79	37.5	15.1	6.41	1.12	21.65	7.92	4.91
PD 3-246	1072	941	88	38.1	13.9	6.88	1.23	22.81	5.43	4.56
Acala SJ-1	1065	836	78	37.9	15.1	6.81	1.15	25.21	6.73	4.86
C.V.	6.16	6.96		1.13	3.04	2.54	0.93	2.78	5.23	3.50
LSD .05	81	78		0.99	0.88	0.36	0.045	1.28	0.81	0.038
LSD .01	108	102		1.42	3.04	0.51	0.065	1.82	1.15	0.054

Planted: April 24, 1968

Harvested: October 23 and November 15, 1968

Table 5. Average performance of 10 cotton varieties at four Delta locations in 1968.

	LINT PER ACRE			Lint percent	Seed index	Boll size grams	FIBER PROPERTIES				
	Total	First pick	Percent first pick				Length— 2.5% 50%	Strength grams/tex	Elonga- tion	Micro- naire	
Stoneville 213	1188	1086	91	39.3	11.2	5.60	1.11	.53	19.05	7.21	4.94
Deltapine 16	1176	1050	89	39.2	11.2	5.99	1.14	.55	19.48	8.37	4.71
Deltapine 45A	1155	998	86	39.4	11.4	5.81	1.10	.56	19.76	7.67	4.62
Stoneville 7A	1149	967	84	38.9	11.1	5.45	1.14	.55	18.88	6.22	4.64
Coker 201	1080	914	84	39.5	11.8	6.08	1.14	.56	19.38	6.30	4.63
Mo 61-470F	1002	850	85	36.9	13.9	6.31	1.14	.58	21.11	8.35	4.43
Stoneville 508	980	817	83	37.0	12.4	6.18	1.19	.57	20.22	7.41	4.12
Coker 413-68	980	811	83	37.7	11.4	5.71	1.15	.55	19.82	6.23	4.28
PD 3-246	959	793	82	37.3	13.1	6.58	1.21	.59	21.88	5.63	4.30
Acala SJ-1	862	665	77	36.7	14.0	6.71	1.15	.59	24.49	6.62	4.62

Table 6. Average performance of eight cotton varieties in eight experiments, 1967-1968.

	Lint Per acre	Lint Percent	Boll size grams/boll	Length 2.5%	Strength grams/tex	Micro- naire
Deltapine 16	1173	39.0	5.92	1.13	19.01	4.52
Stoneville 213	1155	38.8	5.63	1.09	18.45	4.76
Deltapine 45A	1147	39.2	5.72	1.09	19.14	4.48
Stoneville 7A	1117	38.6	5.50	1.12	18.30	4.54
Coker 201	1105	39.2	6.15	1.12	18.75	4.56
Mo 61-470F	994	36.6	6.38	1.13	20.36	4.43
Coker 413-68	967	37.4	5.73	1.15	19.53	4.17
Stoneville 508	953	36.6	6.10	1.18	19.56	3.94

Table 7. Average performance of five cotton varieties in fourteen experiments over a four year period, 1965-1968.

	Lint per acre	Lint percent	Boll size grams/boll	Length 2.5%	Strength grams/tex	Micro- naire
Deltapine 16	1092	38.2	6.00	1.13	19.38	4.72
Stoneville 213	1085	38.0	5.79	1.10	18.73	4.91
Deltapine 45A	1067	38.6	5.77	1.10	19.40	4.74
Stoneville 7A	1054	37.8	5.64	1.13	18.34	4.75
Coker 201	1026	38.6	6.19	1.12	18.89	4.77

COTTON TESTS IN HILL SECTION

Sixteen cotton varieties were tested at eight Hill Section locations in 1968. Varieties previously tested but omitted in 1968 tests included Deltapine 15A, Deltapine Smoothleaf, and Esco Allsmooth.

Results of these tests are intended as an aid to cotton producers in the Hill Section of Mississippi in making decisions concerning which varieties to plant. For this use, the three-year averages are more reliable than any single year's results. For the newer varieties, however, only 1968 data are available and decisions concerning these varieties should be made with caution.

Four varieties were tested for the first time. These were: Acala 1517D, a high quality variety released by New Mexico Agricultural Experiment Station; Atlas 67, a high quality variety released by the Georgia Agricultural Experiment Station; Hybee 401, a high quality variety released by the Pennington Seed Co., and Dunn 56C, a new release from Dunn Pedigreed Seed Co. One variety which was tested in 1967 as an experimental strain designated Mo-61-470F has been named Mo-Del.

Tests were grown successfully at the following locations: Central Station, State College; North Mississippi Branch Experiment Station, Holly Springs, one on hill land and one on bottom land on the farm of Mr. C. C. Moore; Pontotoc Branch Experiment Station, Pontotoc, one on the Flatwoods soil and one on hill soil; Blackbelt Branch Experiment Station, Brooksville; Brown Loam Branch Experiment Station, Raymond; and Coastal Plain Branch Experiment Station, Newton. Cultural practices used in growing the tests at each location are summarized in one of the accompanying tables.

Throughout the Hill Section, except in

North Mississippi, weather conditions were generally favorable for cotton production. Early spring was cool at some locations and stands were reduced sufficiently to require some replanting at Raymond, Brooksville, and Holly Springs (both tests). The summer was generally warm with frequent showers. However, a severe drought occurred at Holly Springs during June and July and damaged yields an estimated 25%.

Performance data for the 16 varieties tested in 1968 and 3-year averages for varieties tested during that period are given in the tables.

Fiber analyses were performed by a commercial testing company and are given for three locations. Fiber data reported include strength which is given in thousand pounds per square inch tensile strength, 2.5% span length which is the length in inches equaled or exceeded by 2.5% of the sample tested and is generally comparable to staple length, uniformity ratio (U. R.) which is given in percentage and is an indication of length uniformity of the fibers in the sample tested. Classers staple length in 32nds inch and micronaire index are given for each variety at all locations.

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Summary Tables

Lint yield, in pounds per acre, of 16 cotton varieties tested at 8 locations in the Hill Section in 1968.

Variety	State College	Brooks-ville	Newton	Raymond	<u>Pontotoc</u>		<u>Holly Springs</u>		Ave.
					Flat-woods	Ridge	Bottom	Hill	
Stoneville 213	1162	1083	1033	1520	874	988	851	724	1029
Deltapine 16	1032	978	1012	1352	858	935	843	680	961
Hancock	929	1158	892	1257	877	1067	762	640	947
Stoneville 7A	1004	929	1060	1337	875	925	766	628	940
Dixie King II	976	1000	1110	1183	840	1063	725	621	939
Coker 201	968	873	1031	1294	962	925	792	599	930
Hybee 200	1006	1041	1024	1410	771	713	582	636	897
Deltapine 45A	974	929	991	1241	773	949	676	600	891
McNair 1032	1067	875	1064	1227	678	890	643	579	877
Coker 413-68	891	764	1013	1304	886	864	669	520	863
Mo-Del	835	870	1041	1070	794	944	702	539	849
Stoneville 508	900	817	953	1217	550	809	630	532	801
Hybee 401	956	933	763	1065	717	849	640	461	797
Atlas 67	823	866	832	1093	688	838	635	489	783
Acala 1517D	900	753	887	882	746	715	692	471	755
Dunn 56C	752	794	813	791	676	660	605	448	692
Average	948	916	969	1202	785	883	700	572	871

Three-year average lint yield of 8 cotton varieties tested at 8 locations in the Hill Section in 1966-1968.

Variety	State College	Brooks-ville	Newton	Raymond	<u>Pontotoc</u>		<u>Holly Springs</u>		Ave.
					Flat-woods	Ridge	Bottom	Hill	
Coker 201	894	655	1092	1072	714	890	601	782	837
Stoneville 213	911	721	1033	1170	613	938	606	659	831
Dixie King II	839	707	1029	1015	705	990	613	683	822
Hybee 200	861	713	1034	1132	606	817	601	629	799
Stoneville 7A	856	634	967	1036	675	936	544	615	782
McNair 1032	850	650	1088	1023	602	804	557	629	775
Deltapine 45A	853	635	993	885	588	906	504	646	751
Coker 413	808	619	992	1038	608	824	478	611	747
Average	859	666	992	1046	638	888	563	656	793

Cultural practices used at cotton variety test locations in 1968.

Location	Soil type	Fertilizer	Plot size		Planting date	Times poisoned
			Length	Width		
		Lbs.	Ft.	No. rows	Mo./day	No.
State College	Verona fine					
	sandy loam	60-60-60	30	1	5/24	15
Brooksville	Houston clay	90-60-60	187	1	5/3	21
Holly Springs						
Hill	Grenada silt loam	73-73-73	70	1	5/8	10
Bottom	Collins silt loam	73-73-73	100	1	5/8	12
Newton	Prentiss loam	72-72-72	90	1	4/19	14
Pontotoc						
Flatwoods	Bude fine					
	sandy loam	89-60-60	50	1	5/3	10
Ridge	Atwood silt loam	89-60-60	50	1	5/1	10

Brown Loam

Cotton variety performance at the Brown Loam Branch Experiment Station, Raymond, in 1968.

Variety	Yield per acre		Lint pct.	Bolls per pound		Pct. first picking	Fiber properties			
	Cotton	Lint		Cotton	Lint		Staple	Mike	Strength	2.5% span
	Lbs.	Lbs.	%	No.	No.	%	1/32 in.	Index	M.P.S.I.	In.
Stoneville 213	3758	1520	40.4	70	173	80	32.6	5.0	86.5	1.02
Hybee 200	3536	1410	39.9	68	170	81	33.3	4.9	87.5	1.04
Deltapine 16	3385	1352	39.9	67	168	80	33.6	4.9	82.5	1.05
Stoneville 7A	3313	1337	40.4	75	187	77	32.6	5.0	93.5	1.04
Coker 413-68	3258	1304	40.0	75	186	78	33.3	5.3	91.5	1.12
Coker 201	3087	1294	41.9	65	156	84	33.3	5.3	88.0	1.04
Hancock	3052	1257	41.2	64	155	92	32.3	5.2	89.0	.99
Deltapine 45A	3134	1241	39.6	69	175	74	34.0	4.8	84.0	1.02
McNair 1032	3187	1227	38.5	70	183	78	33.0	4.9	88.5	1.00
Stoneville 508	3110	1217	39.1	68	174	79	33.0	5.2	84.5	1.11
Dixie King II	2976	1183	39.7	60	152	87	33.3	5.2	87.0	1.00
Atlas 67	2909	1093	37.5	71	188	85	33.3	5.3	100.0	.98
Mo-Del	2815	1070	38.0	63	166	82	34.0	5.1	91.5	1.05
Hybee 401	2630	1065	40.5	73	180	86	33.3	5.2	98.5	1.01
Acala 1517D	24.5	882	36.5	65	179	79	33.3	5.3	91.0	1.14
Dunn 56C	2256	791	35.1	64	182	83	33.0	4.6	96.5	1.06
Average	3051	1202	39.4	67	173	81	33.2	5.0	90.0	1.04
L.S.D. @ 5%		174								
@ 1%		232								
C.V.		13%								

Brown Loam

Three-year averages, Brown Loam Station, Raymond.

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent 1st picking	Staple Length	Mike
	Lbs.	%	No.	%	1/32 in.	Index
Stoneville 213	1170	40.4	77	72	32.7	5.2
Hybee 200	1132	39.9	73	75	33.2	4.8
Coker 201	1072	41.3	74	75	33.2	4.8
Coker 413	1038	40.3	83	69	33.5	4.8
Stoneville 7A	1036	40.3	83	71	33.0	5.1
McNair 1032	1023	39.2	83	69	32.6	5.0
Dixie King II	1015	39.0	65	79	33.6	5.1
Deltapine 45A	885	39.4	83	62	32.8	4.7
Average	1046	39.9	77	71	33.0	4.9

State College

Three-year averages, Central Station, State College.

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent 1st picking	Staple Length	Mike
	Lbs.	%	No.	%	1/32 in.	Index
Stoneville 213	911	37.0	72	82	34.1	4.8
Coker 201	894	40.4	69	85	34.2	4.6
Hybee 200	861	38.2	68	80	34.1	4.7
Stoneville 7A	856	38.0	71	79	34.3	4.8
Deltapine 45A	853	38.7	73	81	33.9	4.7
McNair 1032	850	38.5	76	76	33.6	4.7
Dixie King II	839	38.4	59	80	33.6	4.4
Coker 413	853	38.7	73	81	34.4	4.2
Average	859	38.4	70	80	34.0	4.6

Coastal Plain

Cotton variety performance at the Coastal Plain Branch Experiment Station, Newton, in 1968.

Variety	<u>Yield per acre</u>		Lint pct.	<u>Bolls per pound</u>		Pct. first picking	<u>Fiber Properties</u>	
	Seed Cotton	Lint		Seed Cotton	Lint		Staple	Mike
	Lbs.	Lbs.	%	No.	No.	%	1/32 in.	Index
Dixie King II	2688	1110	41.3	73	177	100	33.0	5.2
McNair 1032	2510	1064	42.4	73	173	100	33.3	5.1
Stoneville 7A	2514	1060	42.2	76	179	100	33.5	5.2
Mo-Del	2528	1041	41.2	71	172	100	34.6	4.9
Stoneville 213	2547	1033	40.5	75	184	100	33.0	5.3
Coker 201	2552	1031	40.4	71	176	100	33.3	5.1
Hybee 200	2457	1024	41.7	66	158	100	33.3	5.2
Coker 413-68	2493	1013	40.6	66	161	100	33.0	4.9
Deltapine 16	2423	1012	41.8	70	168	100	32.6	4.9
Deltapine 45A	2478	991	40.0	69	172	100	34.0	4.9
Stoneville 508	2331	953	40.9	68	166	100	33.6	5.0
Hancock	2264	892	39.4	66	169	100	33.6	4.4
Acala 1517D	2113	887	42.0	68	161	100	33.6	5.1
Atlas 67	2022	832	41.1	72	176	100	34.0	4.9
Dunn 56C	2055	813	39.6	65	164	100	33.0	5.1
Hybee 401	1902	763	40.1	69	172	100	33.6	5.0
Average	2367	969	40.9	69	170	100	33.4	5.0
L.S.D. @ 5%		45						
@ 1%		152						
C.V.		10%						

Three-year averages, Coastal Plain Station, Newton.

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent* 1st picking	Staple Length	Mike
	Lbs.	%	No.	%	1/32 in.	Index
Coker 201	1092	41.9	69	80	33.7	5.1
McNair 1032	1088	41.7	75	74	33.2	5.2
Hybee 200	1034	41.3	69	78	33.6	5.0
Stoneville 213	1033	40.9	72	81	33.8	5.2
Dixie King II	1029	41.4	61	80	33.2	5.0
Deltapine 45A	993	40.8	74	78	34.0	5.0
Coker 413	992	41.2	70	74	33.9	4.7
Stoneville 7A	967	41.2	72	75	33.9	5.1
Average	1028	41.3	70	77	33.6	5.0

* Two year averages, 1966 and 1967.

North Mississippi Hill Land

Cotton variety performance at the North Mississippi Branch Experiment Station, Holly Springs, on hill land in 1968.

Variety	Yield per acre		Lint pct.	Bolls per pound		Pct. first picking	Fiber Properties	
	Seed Cotton	Lint		Seed Cotton	Lint		Staple	Mike
	Lbs.	Lbs.	%	No.	No.	%	1/32 in.	Index
Stoneville 213	1740	724	41.6	90	215	87	33.3	5.4
Deltapine 16	1614	680	42.2	86	204	81	32.6	5.6
Hancock	1503	640	42.6	87	205	84	32.3	5.1
Hybee 200	1539	636	41.3	88	214	84	32.3	5.3
Stoneville 7A	1543	628	40.7	94	231	83	33.0	5.2
Dixie King II	1531	621	40.6	79	196	83	32.0	4.9
Deltapine 45A	1471	600	40.7	98	240	83	32.3	5.1
Coker 201	1408	599	42.6	99	233	81	32.3	5.3
McNair 1032	1391	579	41.6	100	241	81	32.0	5.3
Mo-Del	1356	539	39.7	92	231	77	33.0	5.1
Stoneville 508	1497	532	35.5	86	241	83	33.0	4.5
Coker 413-68	1316	520	39.5	103	260	81	32.6	4.8
Atlas 67	1217	489	40.2	93	232	81	32.6	5.2
Acala 1517D	1262	471	37.4	94	252	87	34.0	4.6
NMB	1149	466	40.6	93	228	80	32.6	5.0
Hybee 401	1307	461	35.2	95	271	79	32.3	5.1
Dunn 56C	1175	448	38.1	86	226	74	32.6	5.0
Average	1412	566	40.1	91	230	82	32.6	5.0
L.S.D. @ 5%		62						
@ 1%		83						
C.V.		11%						

Three-year averages, hill land, North Mississippi Station, Holly Springs.

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent* 1st picking	Staple Length	Mike
	Lbs.	%	No.	%	1/32 in.	Index
Dixie King II	613	41.0	72	85	32.6	4.8
Stoneville 213	606	40.7	86	85	33.5	4.9
Coker 201	601	42.8	91	82	33.1	4.9
Hybee 200	601	40.7	82	84	33.1	4.9
McNair 1032	557	41.0	94	82	32.6	4.9
Stoneville 7A	544	40.2	90	83	33.4	4.9
Deltapine 45A	504	40.8	90	84	32.7	4.8
Coker 413	478	40.2	93	82	33.5	4.7
Average	563	40.9	87	83	33.0	4.8

* Two-year averages, 1966 and 1968.

North Mississippi, Bottom Land

Three-year averages, bottom land, North Mississippi Station, Holly Springs.

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent* 1st picking	Staple Length	Mike
Coker 201	782	39.6	73	90	34.6	4.3
Dixie King II	683	37.5	64	87	34.1	4.5
Stoneville 213	659	36.4	74	90	34.2	4.3
Deltapine 45A	646	36.8	75	89	34.3	4.1
Hybee 200	629	36.5	73	86	34.5	4.5
McNair 1032	629	37.8	77	84	33.8	4.5
Stoneville 7A	615	36.1	76	84	34.6	4.3
Coker 413	611	37.5	83	87	34.9	4.2
Average	656	37.2	74	87	34.3	4.3

* One-year averages, 1968.

Pontotoc, Flatwoods

Cotton variety performance at the Pontotoc Branch Experiment Station, Pontotoc, on flatwoods soil, in 1968.

Variety	<u>Yield per acre</u>		Lint pct.	<u>Bolls per pound</u>		Pct. first picking	<u>Fiber Properties</u>	
	Seed Cotton	Lint		Seed Cotton	Lint		Staple	Mike
	Lbs.	Lbs.	%	No.	-No.	%	1/32 in.	Index
Coker 201	2289	962	42.0	64	151	100	33.3	5.1
Coker 413-68	2144	886	41.3	68	164	100	33.0	4.7
Hancock	2054	877	42.7	62	144	100	32.6	4.9
Stoneville 7A	2101	875	41.6	72	173	100	33.6	5.2
Stoneville 213	2088	874	41.8	74	176	100	34.0	5.4
Deltapine 16	2058	858	41.7	69	165	100	33.3	5.2
Dixie King II	2068	840	40.6	56	137	100	33.0	4.9
Mo-Del	2022	794	39.3	64	164	100	33.6	5.2
Deltapine 45A	1888	773	41.0	71	174	100	33.0	5.3
Hybee 200	1869	771	41.3	65	159	100	33.3	5.0
Acala 1517D	1922	746	38.8	60	155	100	34.3	4.6
Hybee 401	1762	717	40.7	67	166	100	33.0	5.1
Atlas 67	1732	688	39.8	67	169	100	32.6	5.3
McNair 1032	1714	678	39.5	69	174	100	33.3	5.2
Dunn 56C	1798	676	37.6	61	161	100	33.6	4.4
Stoneville 508	1370	550	40.2	69	172	100	33.6	4.3
Average	1929	785	40.7	66	162	100	33.3	4.9
L.S.D. @ 5%		129						
@ 1%		172						
C.V.		12%						

Three-year averages, flatwoods, Pontotoc Station, Pontotoc.

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent* 1st picking	Staple Length	Mike
	Lbs.	%	No.	%	1/32 in.	Index
Coker 201	714	39.9	67	66	34.1	4.6
Dixie King II	705	38.5	58	67	33.5	4.3
Stoneville 7A	675	38.0	70	63	34.8	4.6
Stoneville 213	613	38.0	77	62	34.3	4.7
Coker 413	608	38.3	73	59	34.3	4.2
Hybee 200	606	38.3	68	67	33.9	4.5
McNair 1032	602	38.7	72	61	33.6	4.7
Deltapine 45A	588	39.0	74	66	33.8	4.7
Average	638	38.5	69	63	34.0	4.5

* One-year averages, 1966.

Pontotoc, Ridge

Cotton variety performance at the Pontotoc Branch Experiment Station, Pontotoc, on ridge soil, in 1968.

Variety	Yield per acre		Lint pct.	Bolls per pound		Pct. first picking	Fiber Properties	
	Seed			Seed			Staple	Mike
	Cotton	Lint		Cotton	Lint			
	Lbs.	Lbs.	%	No.	No.	%	1/32 in.	Index
Hancock	2501	1067	42.7	68	159	100	32.6	4.8
Dixie King II	2492	1063	42.7	65	151	100	32.6	4.9
Stoneville 213	2390	988	41.3	75	180	100	33.0	5.2
Deltapine 45A	2286	949	41.5	71	170	100	32.6	5.2
Mo-Del	2444	944	38.6	65	168	100	32.6	4.9
Deltapine 16	2230	935	41.9	70	167	100	33.0	5.1
Stoneville 7A	2274	925	40.7	75	185	100	33.3	5.4
Coker 201	2191	925	42.2	70	166	100	32.6	5.0
McNair 1032	2199	890	40.5	77	191	100	33.0	5.2
Coker 413-68	2127	864	40.6	74	183	100	32.3	5.1
Hybee 401	2113	849	40.2	68	168	100	33.0	5.0
Atlas 67	2190	838	38.3	70	184	100	33.6	5.0
Stoneville 508	2047	809	39.5	71	179	100	34.0	4.5
Acala 1517D	1893	715	37.8	64	168	100	33.6	4.6
Hybee 200	1964	713	36.3	71	195	100	33.6	5.0
Dunn 56C	1791	660	36.9	62	169	100	33.6	4.7
Average	2195	883	40.2	69	173	100	33.0	4.9
L.S.D. @ 5%		131						
@ 1%		174						
C.V.		13%						

Two-year averages (1966 and 1968), Pontotoc Ridge, Pontotoc Station, Pontotoc.

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent* 1st picking	Staple Length	Mike
	Lbs.	%	No.	%	1/32 in.	Index
Dixie King II	990	40.9	64	63	33.0	4.8
Stoneville 213	938	40.6	77	58	33.3	5.3
Stoneville 7A	936	40.0	74	51	33.4	5.4
Deltapine 45A	906	40.6	76	66	33.0	5.2
Coker 201	890	41.3	73	59	33.3	5.0
Coker 413	824	39.2	80	59	33.1	4.9
Hybee 200	817	37.8	74	58	33.3	5.0
McNair 1032	804	40.2	83	56	33.3	5.2
Average	888	40.0	75	58	33.2	5.1

* One-year averages, 1966.

Black Belt

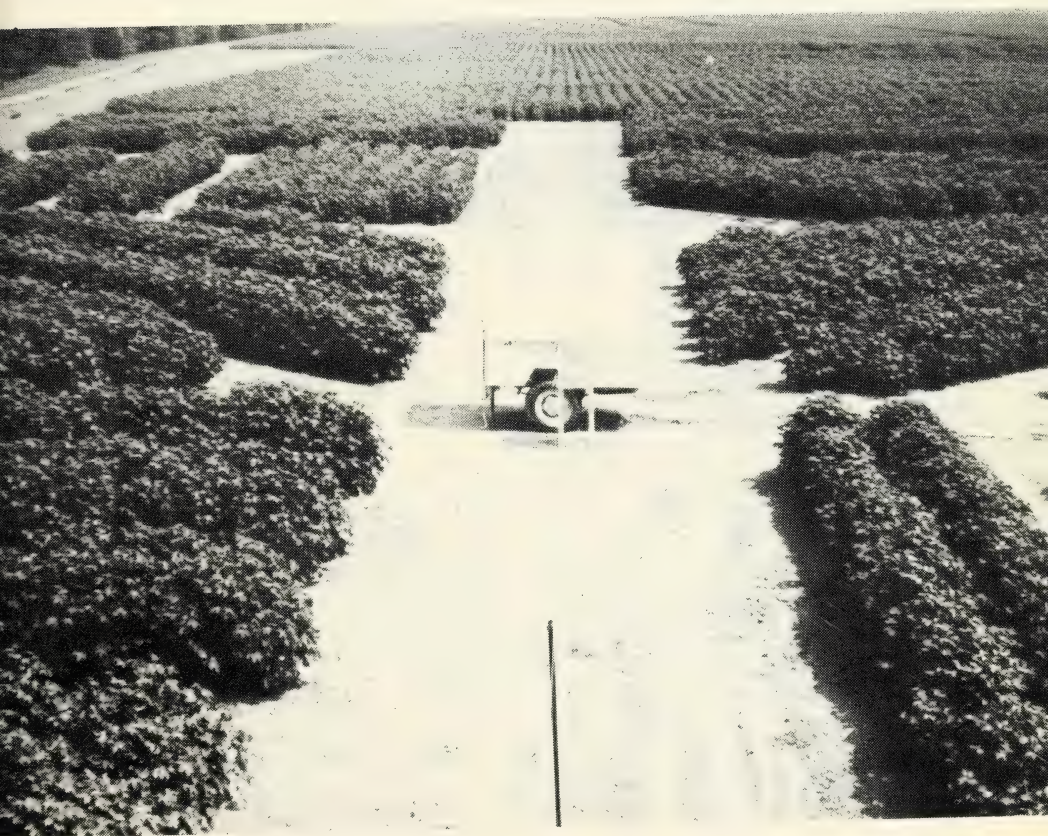
Cotton variety performance at the Black Belt Branch Experiment Station, Brooksville, in 1968.

Variety	<u>Yield per acre</u>		Lint pct.	<u>Bolls per pound</u>		Pct. first picking	<u>Fiber Properties</u>	
	Seed Cotton	Lint		Seed Cotton	Lint		Staple	Mike
	Lbs.	Lbs.	%	No.	No.	%	1/32 in.	Index
Hancock	3089	1158	37.5	70	186	56	33.0	4.8
Stoneville 213	2914	1083	37.2	85	229	43	33.6	5.1
Hybee 200	2751	1041	37.8	85	223	47	33.6	4.8
Dixie King II	2628	1000	38.0	74	194	43	34.0	4.5
Deltapine 16	2621	978	37.3	84	224	51	34.3	4.6
Hybee 401	2549	933	36.6	78	213	56	33.0	5.0
Stoneville 7A	2489	929	37.3	91	245	42	34.3	4.9
Deltapine 45A	2457	929	37.8	88	233	48	33.0	4.6
McNair 1032	2418	875	36.2	90	249	46	33.6	4.9
Coker 201	2292	873	38.1	83	217	48	34.0	4.7
Mo-Del	2436	870	35.7	73	206	51	34.0	4.8
Atlas 67	2431	866	35.6	81	228	52	33.6	5.1
Stoneville 508	2343	817	34.9	87	251	44	34.3	3.8
Dunn 56C	2494	794	31.8	77	243	46	34.3	3.8
Coker 413-68	2215	764	34.5	91	265	46	34.6	4.8
Acala 1517D	2241	753	33.6	71	212	46	34.3	4.5
Average	2460	916	37.2	81	226	47	33.8	4.6
L.S.D. @ 5%		116						
@ 1%		155						
C.V.		11%						

Three-year averages, Black Belt Station, Brooksville.

Variety	Lint per acre	Lint pct.	Bolls per pound	Percent 1st picking	Staple Length	Mike
	Lbs.	%	No.	%	1/32 in.	Index
Stoneville 213	721	38.8	82	65	33.7	5.0
Hybee 200	713	37.9	80	66	33.7	4.6
Dixie King II	707	38.5	68	64	33.6	4.6
Coker 201	655	39.6	79	63	33.9	4.8
McNair 1032	650	37.9	83	63	33.2	4.8
Deltapine 45A	635	38.6	86	67	33.6	4.6
Stoneville 7A	634	38.6	83	64	33.9	4.9
Coker 413	619	36.7	84	66	34.3	4.6
Average	666	38.3	80	64	33.7	4.7

Influence Of Row Direction On Microclimate And Yield Of Skip Row Cotton



Mississippi State University
AGRICULTURAL EXPERIMENT STATION

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STATE COLLEGE

AUG 25 1969

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ON THE COVER:

Figure 1. Two replications of test in 1965 showing row direction plots and instrument housing.

THE INFLUENCE OF ROW DIRECTION ON THE MICROCLIMATE AND YIELD OF SKIP-ROW COTTON

By W. I. SPURGEON¹ and JOHN S. HURSH²

In some of the early skip-row tests conducted at the Delta Branch Experiment Station, it was observed that both row direction and row position influenced cotton yield. For example, skip-row cotton tended to produce more from north to south as compared with east to west rows while solid planted cotton reacted in an opposite manner. The south row always produced more than the north row when cotton was planted in an east to west direction.

The higher yield as affected by row direction and position was believed to be partially associated with the plant microclimate. More specifically, light was considered to be one microclimatic factor responsible for higher yields. Row direction could conceivably influence the amount of light received by cotton plants and consequently affect yield.

An experiment was conducted from 1964 through 1967 to quantitatively measure microclimate regimes in skip-row cotton planted in four new directions. The major regime measured was light with an attempt to correlate this factor with cotton yield.

Materials and Methods

This experiment was conducted at the Delta Branch Experiment Station farm on a Dubbs silt loam soil of medium fertility with respect to phosphorus and potassium. A randomized block design

was used with four treatments replicated four times.

The treatments were 2 x 2 skip-row cotton planted in four-row directions; north to south, east to west, northeast to southwest, and northwest to southeast (Fig. 1). One replication only was used for making microclimatic measurements. One replication was used for yield in 1964 and four were used the last three years.

The principle microclimatic factor which was measured is referred to as light penetration of the cotton foliage. An effort was made to measure light that was reflected from the soil surface after it had penetrated the cotton foliage. This was accomplished by using single silicon solar cells mounted under copper shields and placed in the cotton foliage approximately one foot above the soil surface.

Five solar cells, thus arranged, were placed at intervals of 4 feet apart in each outside row of 2 x 2 cotton within all row directions. The five solar cells for each outside row were parallel wired and connected to Rustak milliamperere recorders (Fig. 2). Separate recorders were used for each outside row of all row direction plots.

The cells and recorders were calibrated by using a constant light source and external shunt of wire of appropriate lengths. The recorders measured on a scale of 0-100 milliamperes with a chart speed of one inch per hour.

The light measurements were started each year at the approximate squaring stage of cotton growth (June 15 to July 1) and continued until the cotton was defoliated in the fall. The daily recorded curves

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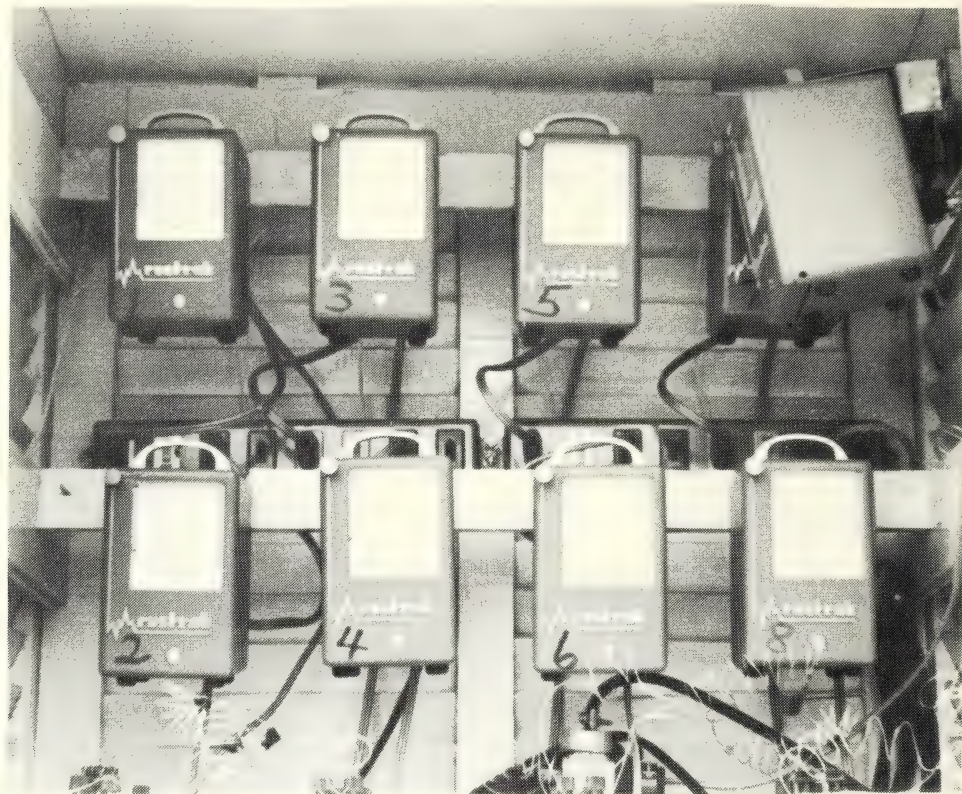


Figure 2. Rustrak recorders in operation.

for light penetration (as reflected by the recorders Fig. 3) were measured with a planimeter in square inch units and expressed on a percentage basis with 10 square inch units equivalent to 100 percent.

The 1965 measurements of wet- and dry-bulb temperatures were recorded in each of the four row directions. An aspirator made up of two thermistors, a squirrel-cage fan and water reservoir was placed between the two rows containing the light sensors. A continuous flow of air was pulled past the wet and dry sensors from one foot above ground level.

Net radiation was measured over bare ground near the center of the project as was the wind speed. A thermal net radiometer was used and its output was

recorded on a scale of $-5/0/+15$ millivolts.

The cotton was planted and cultured in the conventional manner each year until time for installation of the light measuring equipment. The cotton middles, skips and alleys were treated with a sub-surface soil application of trifluralin and diuron immediately before installation of the light equipment. This lay-by treatment adequately controlled weeds and eliminated the need for further cultivation.

The plots were harvested by hand pickers in 1964 and with a mechanical picker modified for plot work the last three years.

Results and Discussion

The light penetration of cotton foliage was influenced by light intensity, wind

velocity, row direction, row position, and the degree of vegetative growth.

Light intensity was very low, during periods of rain, and in fair weather, considerable light restriction occurred as a result of late morning and afternoon cumulus clouds (Fig. 3-A, C and D).

High wind velocity caused more plant movement which resulted in greater light penetration of foliage. The wind velocity was variable but, generally, velocity was highest during the early and late parts of the growing season.

The light penetration was greatest, in 2 x 2 skip-row cotton where the rows were directed perpendicular to the sun (Fig. 3-C and D). The greatest light penetration of cotton foliage for the four row directions was in the descending order of north to south, northeast to southwest, northwest to southeast and east to west rows (Fig. 4).

The amount of vegetative growth, in-

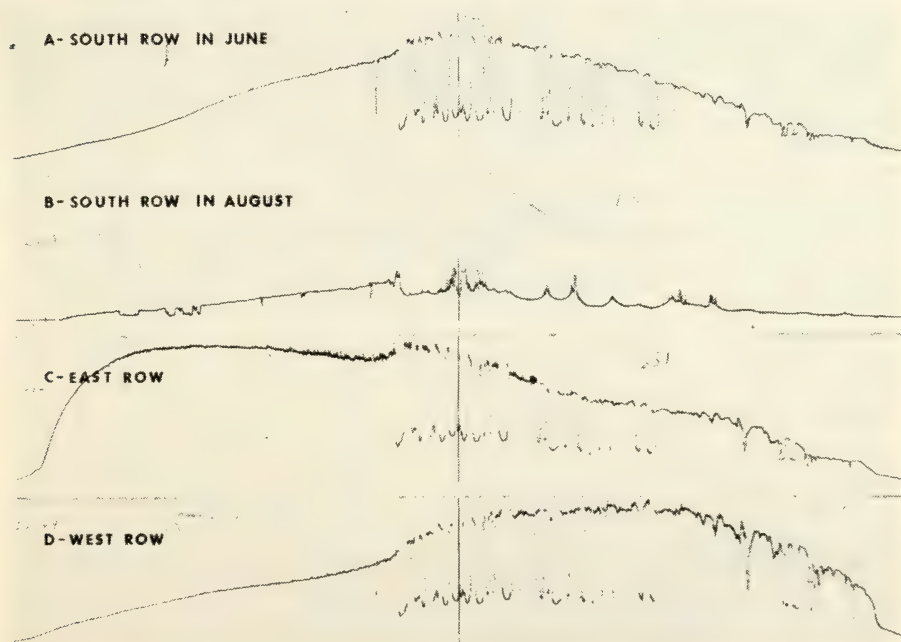
fluenced light penetration of cotton foliage. Light penetration was high at the initiation of the measurement period (Fig. 3-A). but decreased as vegetative growth increased until a low point was reached in August (Fig. 3-B).

Since only one replication was used in 1964 these data are reported separately. The data for 1964 as shown in Table 1 does not show any relationship between percent light and cotton yield with respect to row direction. It does, however, indicate that within any given row direction the row which received the most light produced the most cotton.

The difference in yield between row directions is due to soil position. The east to west and northwest to southeast rows were on better soil sites.

In 1965, a 40-day period (July 13-Aug. 21) of daytime temperatures and relative humidities was analyzed but differences between row directions were very small

FIG. 3-RECORDER CURVES FOR LIGHT IN 1964



and no significant relationships between these two elements and yields could be established.

The effect of row direction and position on light penetration of plants and yields for 1965, 1966, 1967 and the 3-year average are shown in Table 2. The percent of light penetration as shown for each year is an average for the total period of measurement. The percent light figures were lower in 1965 as compared with the two latter years because the cotton was earlier with more vegetative growth when the light measurements were begun.

Although light penetration was greater for plants of different row directions (Fig. 4), there were no significant differences in yield between row directions for any year.

Within three row directions, north to south, east to west, and northeast to southwest, the row with the greatest light penetration produced the most cotton. However, the yield difference between rows which received more as opposed to less light was not significant, except in 1966. An exception was the northwest to southeast rows where the row with less light penetration produced more cotton.

Figure 5 shows the percent light penetration of cotton (4-year average of row directions) along with the mean air temperature as recorded at the Stoneville

Weather Station for the same period. The average light penetration and temperature are plotted at intervals of two weeks. Temperatures are shown only to illustrate uniformity when averaged for the 4-year period.

During the first two-week period light penetration was high because the cotton plants were small. As vegetative growth increased light penetration decreased until a low was reached at the two-week period of August 7-20 (Fig. 5). This low point of light penetration represents the greatest stage of vegetative growth.

Immediately following the vegetative peak, light penetration increased rapidly which indicated that maturity was likewise rapid. Percent light penetration was correlated with cotton yield for two of the two-week periods. During the period of greatest vegetative growth (Aug. 7-20) light penetration was negatively correlated with yield. At the Sept. 4-17 period, or four week following the peak of vegetative growth, there was a positive correlation between percent light penetration and yield. It appears that light penetration, as determined in this experiment, more effectively measured the stage of vegetative growth and maturity—rather than the effect that quantity of light had upon yield.

Two week averages of percent light

Table 1. Effect of row direction and position on light penetration and yield of 2x2 skip-row cotton (1964).

Row Direction	Row Position	Percent light*	lbs. seedcotton
			per acre
North-South	East	63.6	4313
	West	77.7	5219
	Average	70.7	4766
East-West	North	54.5	5619
	South	56.0	5733
	Average	55.3	5676
Northeast-Southwest	Northwest	61.4	4722
	Southeast	77.5	5132
	Average	69.5	4927
Northwest-Southeast	Northeast	61.4	5323
	Southwest	66.4	5680
	Average	63.9	5502

* Relative light penetration into plant canopy (average from June 26 through Sept. 17).

FIG. 4. PERCENT LIGHT PENETRATION AS INFLUENCED BY ROW DIRECTION AND POSITION.

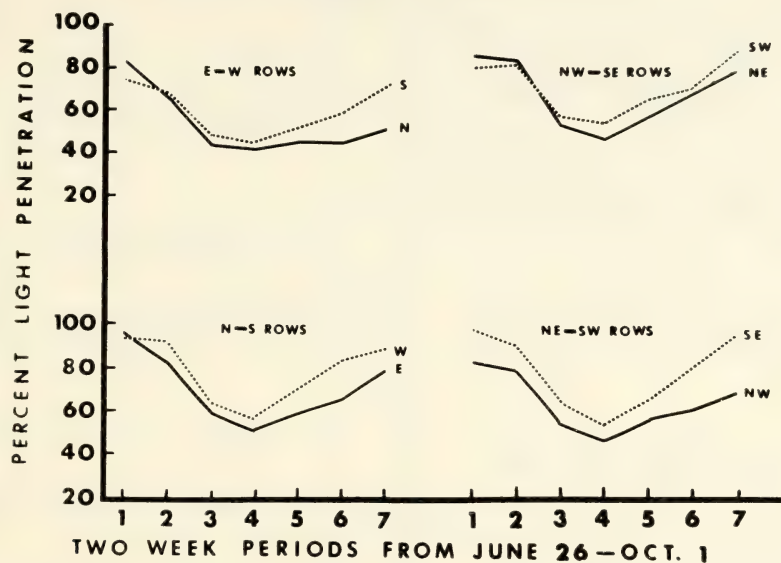


FIG. 5. PERCENT LIGHT PENETRATION OF COTTON (ROW DIRECTION AVERAGE FOR 4 YEAR PERIOD) AND MEAN TEMPERATURE

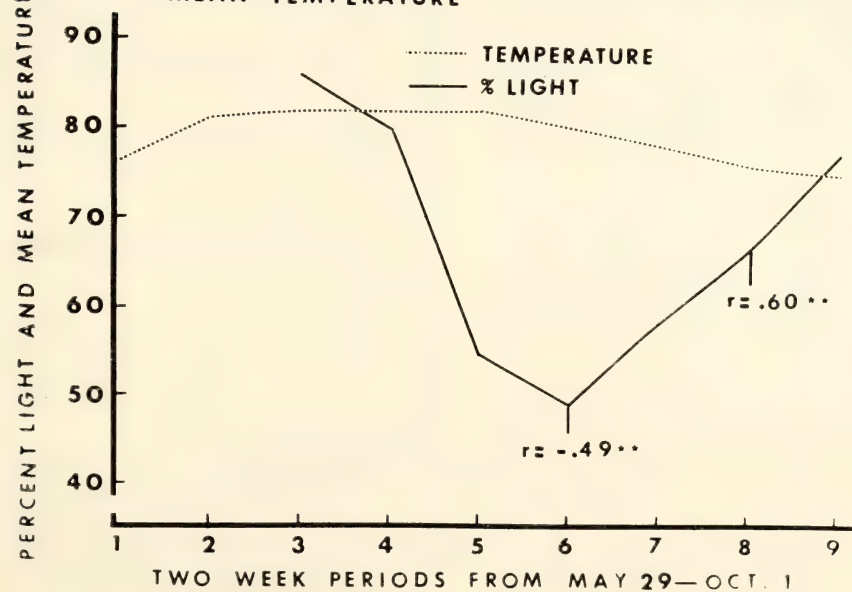


Table 2. Effect of row direction and position on light penetration and yield of 2x2 skip-row cotton (1965-1967).

Row Direction	Row Position	1965			1966			1967			3-year average	
		% light	Yield	% light	Yield	% light	Yield	% light	Yield	% light	Yield	Yield
North-South	East	54.9	4378	71.3	4657	76.3	3612	67.5	4216			
	West	61.6	4544	78.4	5031	81.7	4051	73.9	4542			
	Average	58.3	4461	74.9	4844	79.0	3831	70.7	4379			
East-West	North	46.3	4538	50.3	4587	52.3	3190	49.6	4105			
	South	49.8	4639	68.2	4693	52.3	3320	56.8	4217			
	Average	48.1	4589	59.3	4639	52.3	3255	53.2	4161			
Northeast-Southwest	Northwest	55.1	4396	70.4	4378	61.8	4146	62.4	4307			
	Southeast	59.5	4526	79.7	5019	81.9	4704	73.7	4750			
	Average	57.3	4461	75.1	4699	71.9	4425	68.1	4528			
Northwest-Southeast	Northeast	48.6	4508	73.8	5186	69.7	3748	64.0	4481			
	Southwest	53.6	4289	74.1	4485	75.4	3629	67.7	4134			
	Average	51.1	4399	73.9	4835	72.6	3689	65.9	4308			

Table 3. Average temperatures (F°) and total rainfall as recorded at the Delta Branch Experiment Station Stoneville, Mississippi from 1964-1967.

Two-Week Start	Periods End	1964			1965			1966			1967		
		Temp. Max.	Temp. Min.	Rainfall inches	Temp. Max.	Temp. Min.	Rainfall inches	Temp. Max.	Temp. Min.	Rainfall inches	Temp. Max.	Temp. Min.	Rainfall inches
April 3 - April 16	April 16	73	52	4.10	80	62	1.62	71	47	0.66	81	61	1.97
April 17 - April 30	April 30	79	61	5.53	77	53	1.27	77	59	0.66	76	56	1.06
May 1 - May 14	May 14	82	62	0.85	85	63	T	79	57	1.41	79	60	2.52
May 15 - May 28	May 28	90	64	0.18	86	67	4.27	84	64	1.44	81	59	3.38
May 29 - June 11	June 11	86	62	0.62	89	67	0.05	88	63	T	84	66	2.25
June 12 - June 25	June 25	96	74	0.13	87	66	2.11	90	67	0.77	94	72	0.25
June 26 - July 9	July 9	94	72	2.89	93	72	1.05	93	71	2.30	89	71	1.75
July 10 - July 23	July 23	92	70	1.34	95	72	0.38	97	75	0.59	87	67	1.06
July 24 - Aug. 6	Aug. 6	95	73	0.54	92	69	0.47	92	71	0.69	91	73	1.55
Aug. 7 - Aug. 20	Aug. 20	88	68	2.49	93	70	1.26	92	70	1.57	87	67	0.72
Aug. 21 - Sept. 3	Sept. 3	91	70	0.56	89	70	0.91	88	64	0.62	84	63	0.29
Sept. 4 - Sept. 17	Sept. 17	90	63	T	89	69	2.96	85	63	0.39	81	64	0.99
Sept. 18 - Oct. 1	Oct. 1	83	61	2.77	81	62	1.54	82	59	1.16	82	57	0.92
Oct. 2 - Oct. 15	Oct. 15	71	48	0.60	77	54	0.94	79	52	0.92	80	52	0.15
Oct. 16 - Oct. 29	Oct. 29	76	47	0.07	74	46	T	68	44	1.29	74	47	0.59
April 3 - Oct. 29	Oct. 29	86	63	22.67	86	64	18.83	84	62	16.33	83	62	19.45

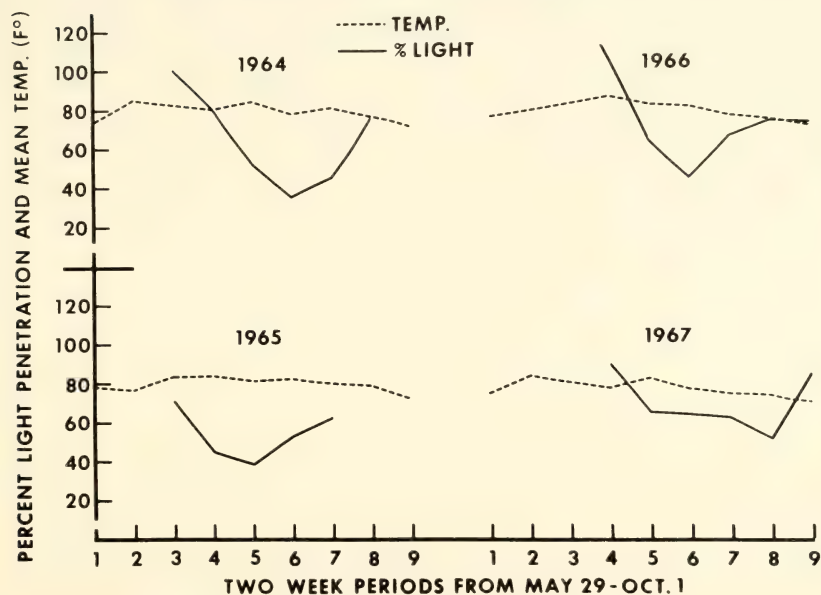
penetration of cotton and the mean temperatures for the growing season of each year are shown in Figure 6. The lowest point of percent light penetration, as previously mentioned, coincides with the peak of vegetative growth. As illustrated in Figure 6, this peak of vegetative growth seems to give a reliable indication of the maturity date of cotton.

In 1964 and 1966 the vegetative peak was reached during the 6th two-week period (Aug. 7-20). The mean temperatures were relatively high in 1964 and 1966 with some minor fluctuation but did not fall much below 80° during the critical growing period.

In 1965 the vegetative peak occurred during the 5th two-week period, or two weeks earlier than in 1964 and 1966. The mean temperature was uniformly high (above 80°) during the growing period.

In 1967 the vegetative peak of growth and maturity occurred during the 8th two-week period (Sept. 4-17). The delay in vegetative growth and maturity was probably caused by a combination of low temperatures from July 10-23 (Fig. 6) and relatively high rainfall from June 26 through August 6 (Table 3). As a result of late maturity the 1967 cotton yield was much lower than that of the three previous years.

FIG. 6. PERCENT LIGHT PENETRATION OF COTTON AND MEAN TEMPERATURE DURING THE GROWING SEASONS (1964-1967)



Summary

An experiment was conducted at the Delta Branch Experiment Station from 1964-1967 to measure microclimatic regimes in 2 x 2 skip row cotton planted in four row directions. Light penetration of the cotton foliage was measured during each growing season for four years and relative humidity and temperature were measured for one growing season in 1965. Summary statements are listed below:

1. Row direction had no effect on relative humidity and temperature as measured within the plant canopy in 1965.

2. There was no significant difference in cotton yield between row direction during any year or for the four-year average.

3. Within row directions, the row which received the most light usually produced more cotton. However, the

difference in yield between rows receiving more as opposed to less light was not significant, except in 1966.

4. Light penetration of the cotton foliage was higher for row directions more nearly perpendicular to the path of the sun.

5. There was no correlation between light penetration and cotton yield except for two periods during the growing season. A negative correlation was found during the two-week period of greatest vegetative growth (Aug. 7-20), while a positive correlation was found four weeks after the peak of vegetative growth, or during the two-week period (Sept. 4-17).

6. The percent light penetration of cotton foliage, as determined in this experiment, more effectively measured the stage of vegetative growth and plant maturity rather than the effect that quantity of light had upon yield.



The Southwestern Corn Borer And Its Control

By C. A. HENDERSON and FRANK M. DAVIS

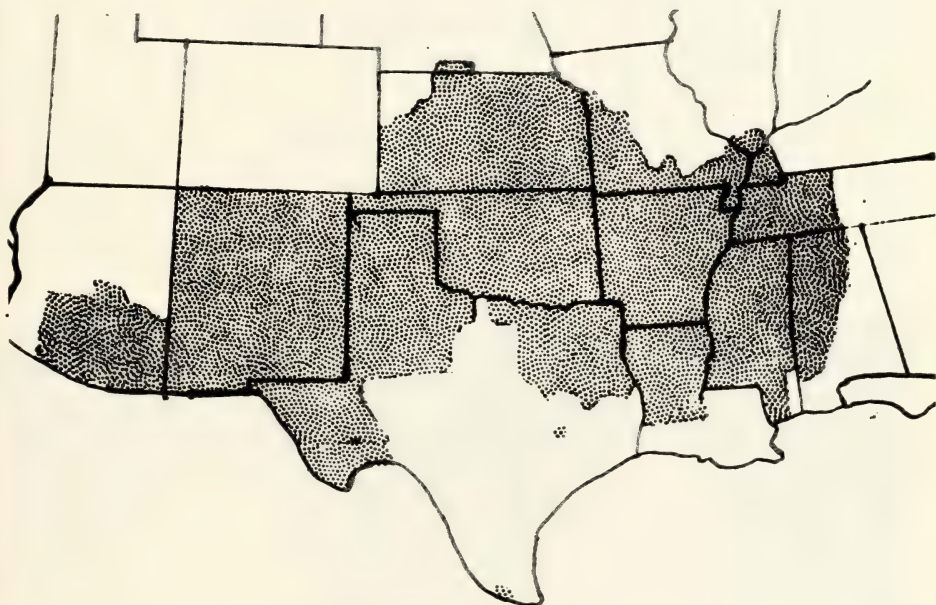


Figure 1. Known distribution of the southwestern corn borer in the United States.

Mississippi State University

AGRICULTURAL EXPERIMENT STATION

JAMES H. ANDERSON, Director

STATE COLLEGE

MISSISSIPPI

In Cooperation With The Entomology Research Division
Agr. Res. Ser. U.S.D.A.

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COMMON AND SCIENTIFIC NAMES OF INSECTS DISCUSSED

Common Name	Scientific Name
A mite	<i>Caloglyphus</i> sp.
Corn earworm	<i>Heliothis zea</i> (Boddie)
European corn borer	<i>Ostrinia nubilalis</i> (Hbn.)
Fall armyworm	<i>Spodoptera frugiperda</i> (Smith)
Southern cornstalk borer	<i>Diatraea crambidoides</i> (Grote)
Southwestern corn borer	<i>Diatraea grandiosella</i> (Dyar)
Sugarcane borer	<i>Diatraea saccharalis</i> (F.)
None	<i>Trichogramma minutum</i> (Riley)

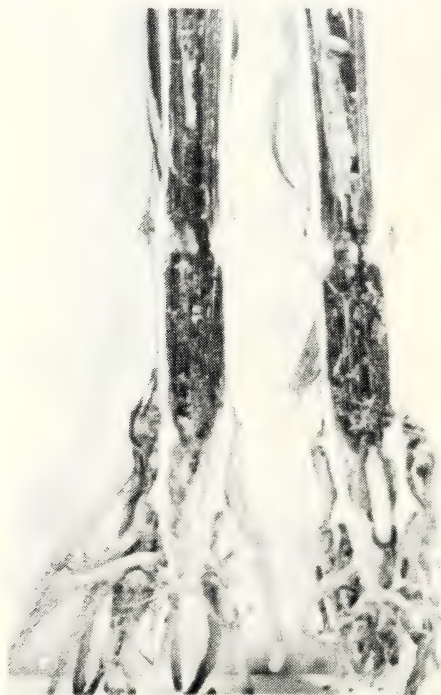


Figure 2. Overwintering larva in the base of a cornstalk.

THE SOUTHWESTERN CORN BORER AND ITS CONTROL

By C. A. HENDERSON and FRANK M. DAVIS

The southwestern corn borer is one of the most destructive pests of corn in the South and Southwest. Since first reported in the United States from Lakewood New Mexico in 1913 it has spread eastward to Central Alabama and Central Tennessee and northward to southern Kansas. All or portions of 14 states are infested (Fig. 1).

All types of corn are the preferred hosts; however, sorghums, sugarcane, broomcorn, Sudangrass and Johnsongrass are hosts.

Description and Habits

The southwestern corn borer has four stages in its life cycle: egg, larva or borer, pupa, and adult.

The number of generations of this

insect varies with latitude but may be also influenced by weather. In its northernmost areas there are only two generations per year. In southern areas three generations and a partial fourth may develop annually.

Full-grown creamy-white larvae overwinter in the lowest part of the main stem of the host plant (Fig. 2). These larvae pupate in the base of the old stalks from April 15 to May 15 and first generation adults (Fig. 3) emerge from May 1 to May 30. Figure 3A shows the approximate length of generations and the time each occurs during the year. This may vary a week from year to year.

The eggs are commonly oviposited singly in a chain or in a mass and

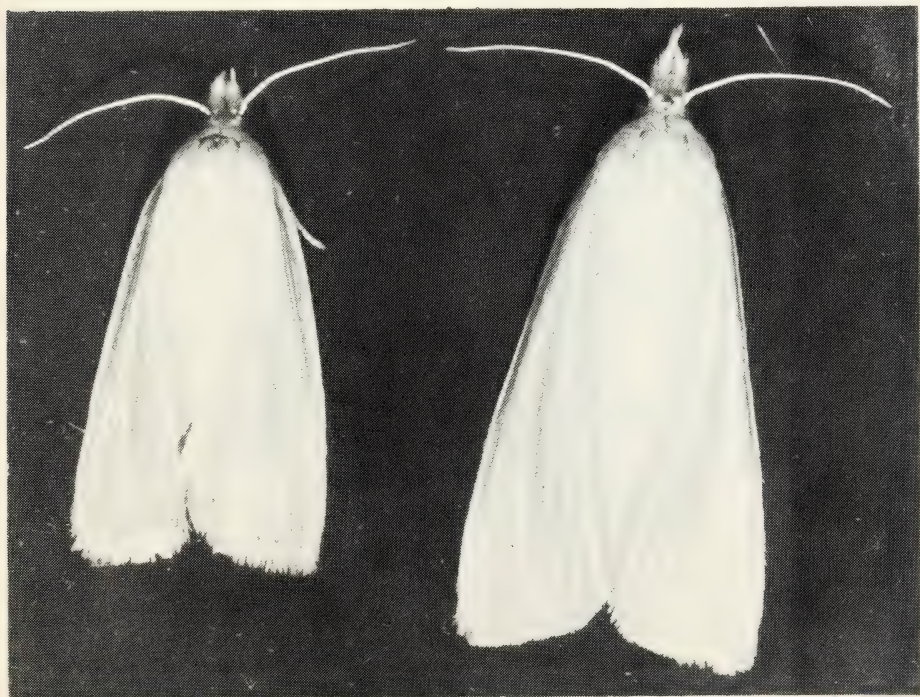


Figure 3. Moths; male on left, female on right.

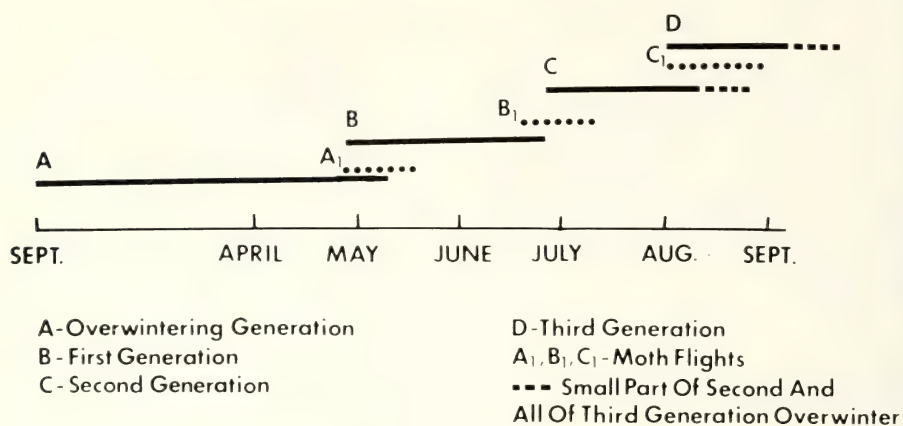


Figure 3-A. Length of generations and time each occurs.

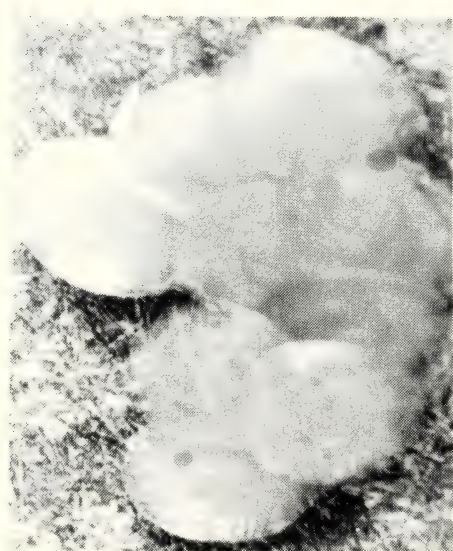


Figure 4. Fresh oviposited egg mass.



Figure 5. Egg mass with transverse orange-red bands.



Figure 6. Summer form of full-grown larva of southwestern corn borer.

overlap one another as shingles on a roof (Fig. 4). The average number of eggs per mass is 2. They are very small and are usually found on the upper and lower surface of the corn leaf, but some have been found on the stalk. When first oviposited the eggs are greenish white. They gradually become lighter for 24 to 36 hours gradually becoming cream colored with 3 parallel transverse orange-red lines dividing each egg into 4 more or less equal parts (Fig. 5). About 24 hours before hatching the egg becomes a light yellowish color and the head of the enclosed larva may be seen through the shell as a black spot. The incubation period is from 4 to 7 days.

The larvae of the southwestern corn borer present a summer and a winter form. The summer form (Fig. 6) occurs in the corn plant above ground

level during the summer, is milky-white with a brown head, and bears brownish-black dots on the body. The winter form (Fig. 7) occurs in the base of the plant usually below ground level from October to April. This form is a light creamy-yellow color or a little darker than the summer form, and the head less intensely brown. The brownish-black dots of the summer form are missing in the winter form. When full grown the larva is about 1 inch long. Many overwintering larvae girdle the stalk internally near or a few inches above ground level from mid-August to mid-October causing

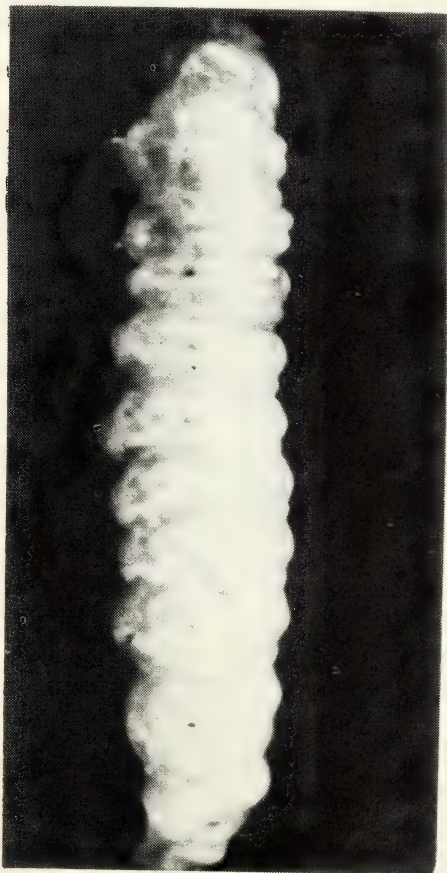


Figure 7. Winter form of full-grown larva of southwestern corn borer.



Figure 8. Pupae.



Figure 9. Young corn plant showing "dead heart" and typical injury to leaves by small larvae.



Figure 10. A girdled cornstalk.

the plants to fall over. Not all of the larvae girdle the stalks.

On completing its development the larva transforms into the pupa or resting stage (Fig. 8). The newly formed pupa is about the same color as the larva. It gradually assumes a dark-brown color. The pupa ranges between one-half and one inch in length. The average weight of the pupae is females 257 mg, males 124 mg.

The adult is a dull white colored moth. Females have a wing span of 30 to 40 mm and males have a wing span of 20 to 30 mm. When at rest the wings are folded close over the body. The males are slightly smaller than the females and a little darker in color (Fig. 3). Females oviposit an average of about 350 eggs. The average longevity for all generations was 4.4 days for females and 4.1 days for males.

Damage

Injury to the plant is caused exclusively by the larva. Practically all parts of the corn plant are damaged to some degree, although the most severe injury results from feeding on the growing point or "bud," and the stalk proper.

Bud injury to young corn by the larvae is often serious. This destruction of the central leaves of the young plant is commonly called "dead heart," and causes the plant to die or to become deformed, stunted, and unproductive (Fig. 9). Injury to the plant can be caused in several ways: (1) young plants are killed or dwarfed by borer activity in the stalk; (2) yield is reduced by extensive tunneling in the stalks; and (3) grain is lost as a result of stalk girdling (Fig. 10) in the fall.

Stalk girdling is the result of overwintering larvae cutting a V-shaped groove around the inside of the stalk near, or a few inches above, ground level. Girdling activity occurs generally from mid-August until harvest. Some infested stalks escape girdling entirely, and others are not girdled sufficiently to cause breakage, but many girdled stalks fall of their own weight or are blown over by wind (Fig. 11). The loss caused by rodents, rot, and mold occasioned by this activity may be great, depending on weather conditions, prevalence of rodents, and other factors. Where mechanical harvesters are used the lodged corn is not picked. Salvage



Figure 11. Corn stalks broken and lodged due to girdling by the larvae.

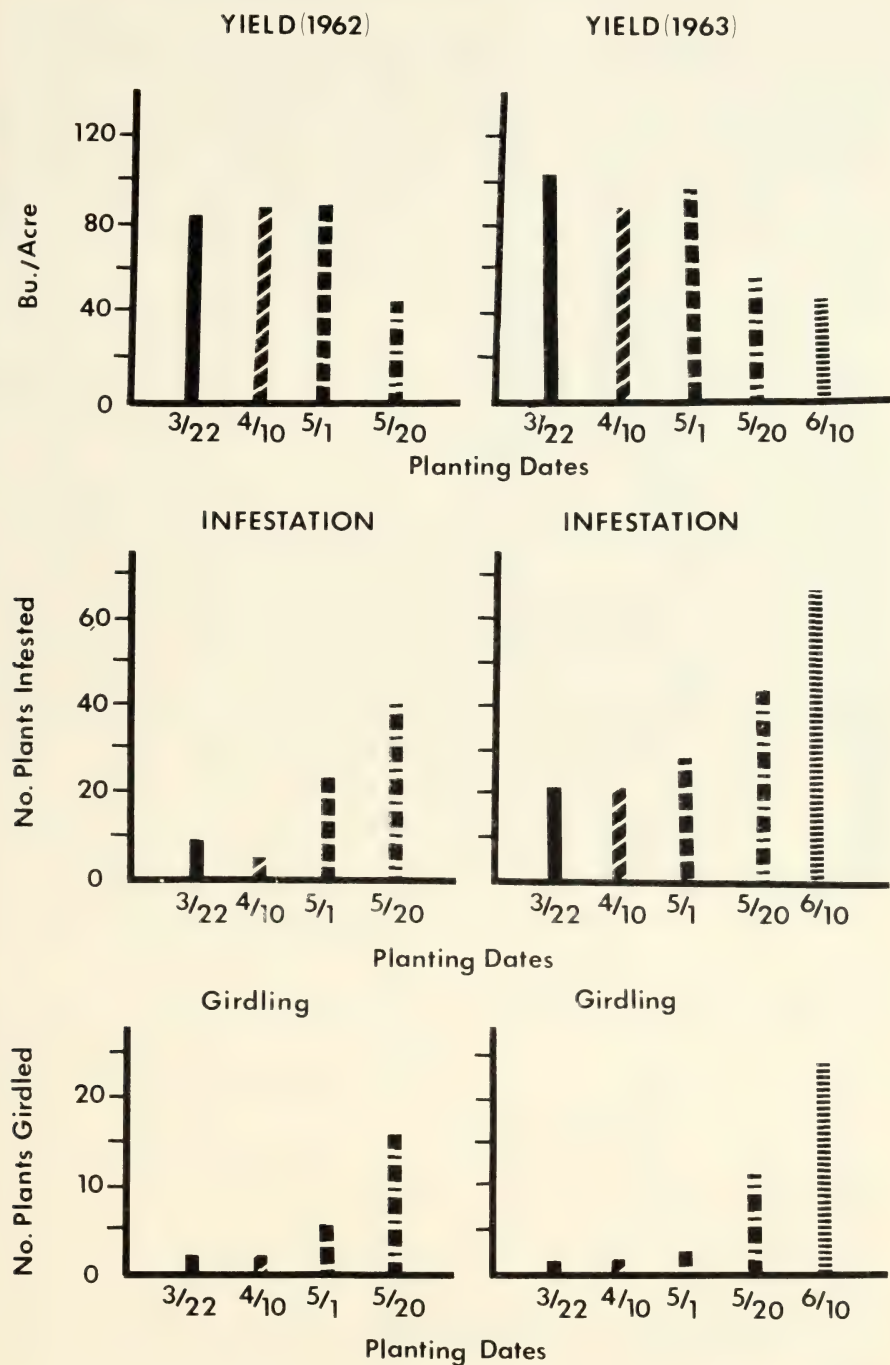


Fig. 12. Yield, borer infestation and stalk girdling by planting dates in 1962-63. These data taken from a published report in Journ. Econ. Entomol. Vol. 60, No. 3, pp. 709-711, June 1967.

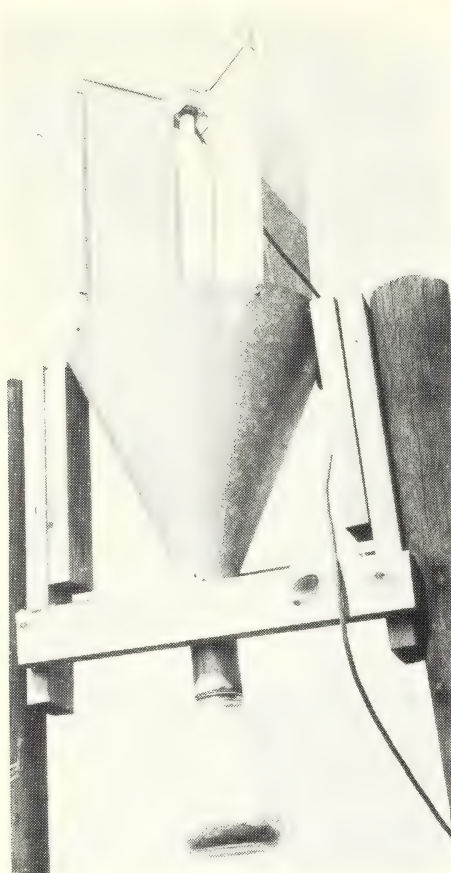


Figure 13. Black light insect trap.

necessitates gleaning, an expensive operation, unless fields are equipped so livestock can utilize the downed corn.

Control

Control of the southwestern corn borer may be achieved to some degree by: early planting, cultural practices and use and timing of insecticides.

Research is being conducted to develop hybrids that are tolerant or resistant to this insect.

Adjusting planting dates: In Mississippi, maximum corn yields are obtained by selecting planting dates late enough so seedling vigor will not be reduced by

cold, wet weather and early enough so the corn escapes some of the hot, dry weather that usually occurs late in the growing season.

In tests at State College and Stoneville, Miss. over a 2-year period, corn planted by May 1 yielded significantly more and had significantly fewer plants infested and girdled than corn planted on May 20 and June 10 (See Fig. 12). Therefore it is advisable to plant corn as early as practicable.

Early planting of corn is the most practical and economical method of controlling the southwestern corn borer in Mississippi.

Chemical Control on Corn: Chemical treatment may be desirable on highly productive land or where the crop is of special value, such as corn grown for seed production. Treatment of early-planted corn generally is of little or no value. When it is necessary to plant corn late, after May 10, it is usually beneficial to chemically control the borer, especially in the north half of Mississippi.

The timing of applications of chemicals is critical for control of the southwestern corn borer. A black light insect trap (Fig. 13) located near the test field was used for this purpose after 1964. One week after the first southwestern corn borer moth, of a generation, was trapped the first application of insecticide was made for control of that generation of borers. This usually occurs the last days of June for second generation borers, and the last days of July or the first part of August for third generation borers at State College, Mississippi. Each generation of borers occurs about 7 or 8 days later in the vicinity of Holly Springs, Mississippi.

Research to develop chemical control methods for the southwestern corn borer in Mississippi was started in 1961. Results with the various insecticides were obtained in experimental plots and should not be considered recommendations. In the first test 0.5 lbs. endrin, 1.5 lbs. car-

baryl and 2.0 lb/acre DDT in 30 gallons of water were applied into the whorls of the plants. Three applications at 1 week intervals were made beginning when the first larvae were observed on the plants.

In 1962, 1963 and 1964 tests were conducted at State College, Holly Springs, and Stoneville, Mississippi using granular formulations of endrin 0.5 lb., and carbaryl 1.5 lb/acre. Diazinon granules 1.25 lb/acre were tested in 1964, and carbofuran granules at a rate of 1.0 lb/acre were included in the 1964 tests. The first of three applications of the chemicals was made when approximately 25% of the plants showed leaf-feeding by the young borers. The other two applications

were made at weekly intervals after the first.

Endrin was significantly more effective than carbaryl or diazinon in reducing the degree of infestation and the number of girdled stalks (Table 1). All treatments were significantly better than the untreated check.

In 1966 and 1967 a four-treatment application schedule was followed. Two applications a week apart were made for control of second generation borers and two applications a week apart for control of the third generation borers. The granular insecticides were applied into the whorl of the corn plants for second generation borer control, or to the ear

Table 1. Tests of control of the southwestern corn borer with 3 applications of insecticides in 1964

Treatment	% stalks infested	% stalks girdled	Yield (Bu/A)
<u>Holy Springs, Miss.</u>			
Endrin gran. 0.5 lb/A	24.2a	8.5a	45.7a
Diazinon gran. 1.25 lb/A	63.8b	30.5b	44.8a
Carbaryl gran. 1.5 lb/A	73.9c	36.8c	40.5a
Check (untreated)	87.8d	45.0d	39.4a
<u>Stoneville, Miss.</u>			
Endrin gran. 0.5 lb/A	51.1a	16.4a	53.1a
Diazinon gran. 1.25 lb/A	73.4b	24.0b	50.0a
Carbaryl gran. 1.5 lb/A	82.2c	27.8bc	50.9a
Check (untreated)	95.9d	31.4c	35.1b

These data are taken from published report in Journ. Econ. Entomol. Vol. 60, No. 3 pp 629 - 634, June 1967.

Table 2. Tests of control of the southwestern corn borer with 4 applications of insecticides in 1967.

Treatment	% stalks infested	% stalks girdled	Yield (Bu/A)
<u>Holy Springs, Miss.</u>			
Carbofuran gran., 0.5 lb/A	13.0a	2.0a	77.1a
Endrin gran., 0.5 lb/A	14.4a	5.0a	71.5a
Endosulfan gran., 0.5 lb/A	19.0a	7.0a	68.7a
Check (untreated)	71.0b	42.0b	59.4a
<u>State College, Miss.</u>			
Endrin gran. 0.5 lb/A	15.8a	5.5a	40.2a
Carbofuran gran. 0.5 lb/A	13.5a	5.8a	39.0a
Endosulfan gran. 0.5 lb/A	11.2a	6.8a	38.0a
Check (untreated)	75.5b	29.8b	30.7a

All means followed by the same letter are not significantly different at the 5% level, as determined by Duncan's New Multiple Range Test.



Figure 14. Hahn Hi-Boy machine used to apply insecticides.

zone area of the plants for third generation borer control.

Endrin, endosulfan and carbofuran each applied at a rate of 0.5 lb. active ingredient per acre per application gave significantly better borer control than the untreated check (Table 2). No significant differences in borer control were noted among chemicals.

Azodrin emulsifiable concentrate at a rate of 1.0 lb. in 16 gallons of water per acre per application using two applications for control of second generation borers and two applications for third generation borers gave significantly better borer control than the untreated check in 1966 and 1967.

Carbofuran granules (3%) applied to the soil at a rate of one pound actual material per acre, per application showed

some promise as a systemic insecticide when 3 applications were made at planting time, mid-June and mid-July.

Equipment for Applying Insecticides:

A Hahn Hi-Boy machine was used to apply the insecticides. However, most any high-clearance machine is or can be made adequate for insecticide applications. Equipment for attaching to a high-clearance machine for the application of granular insecticides is available commercially. Kow-crop dusters are not satisfactory for applying granules.

A two-row Gandy hopper attached to a Hahn Hi boy machine was adjusted to distribute the proper amount of insecticide in tests at State College and Holly Springs, Miss. (Fig. 14). A small hydraulic motor mounted adjacent to the hopper (Fig. 14) was used to operate the hop-

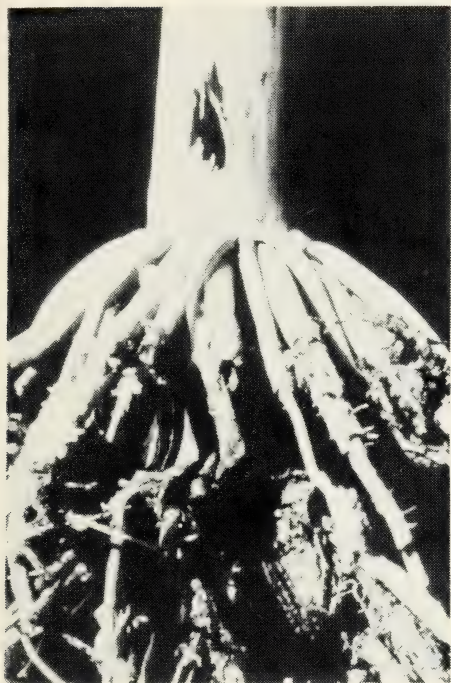


Figure 15. Bird peck hole in cornstalk.

per's agitator, thus insuring a steady flow of granules.

Cultural Practices for Control: The effect of fall plowing and disking on borer survival was determined. Over a 3-year period, each fall corn stalks were either double disked with a tandem disk or thrown out of the row with a middle buster plow in three different areas of a field. The following April of each year 100 randomly selected stalks in each of the three areas were split and the southwestern corn borer mortality was calculated. The results show that fall disking will reduce overwintering populations of the borer about 98 percent. However, if disking is to be of value in reducing populations of the southwestern corn borer, it must be practiced over a large geographical area. The adult insects are strong fliers and can migrate from undisked fields. Deep plowing has not given satisfactory control.

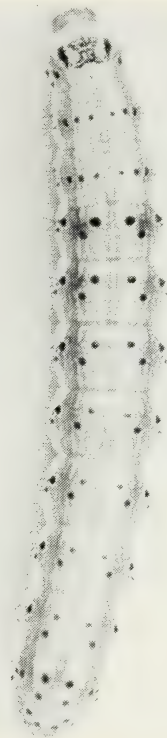


Figure 16. Corn earworm (Photo by Southern Grain Insects Research Laboratory, Tifton, Ga.)

Overwintering borers are susceptible to winter temperatures when not protected by soil around the stubble. Fall disking of corn stubble will kill some borers and many die from exposure to weather and natural enemies.

Natural Enemies

Trichogramma minutum (Riley) is a parasite of the southwestern corn borer. This minute, yellow, hymenopterous insect, which scarcely can be seen with the unaided eye, oviposits in the eggs of the borer. Parasitized borer eggs become black and fail to hatch. The degree of parasitism has been light in Mississippi.

A mite, *Caloglyphus* sp., has been observed clinging to the overwintering larvae in the base of the stem of the cornstalks in the fall and winter. No more than 3 mites per live larva have been ob-



Figure 17. Fall armyworm (Photo by Southern Grain Insects Research Laboratory, Tifton, Ga.)



Figure 18. Southern cornstalk borer. (Photo by J. A. DuRant, Clemson State Univ., Florence, S.C.)

served in the field. Several of these larva were brought into the laboratory and isolated until they died or pupated. After the death of a larva the mites multiplied rapidly. Mites have also been found on southwestern corn borer pupae. These mites are scarce in the field and of doubtful importance.

A bird, the flicker, (*Colaptes auratus*) has been observed in the act of feeding on the overwintering larval stage of the borer. This woodpecker has been seen pecking holes in cornstalks (Fig. 15) usually from 1 to 3 inches above ground level, and with his long, barbed tongue, taking overwintering larvae from the base of the stalk. Predation ranged from

66.0% to 0% in 30 examined fields. It appeared to be greatest in fields adjacent to or near the wooded areas.

Larvae Mistaken for the Southwestern Corn Borer

Several larvae found in corn, either similar in appearance or type of damage, are often mistaken for the southwestern corn borer.

Corn Earworm. The corn earworm (Fig. 16) often feeds on the leaves in the whorl of the corn plant and causes damage similar to that of the southwestern corn borer. Larval color of the corn ear-



Figure 19. European corn borer (Photo by Corn Borer Research Laboratory, Ankeny, Iowa)

worm varies from tints of green, pink, yellow, and brown to almost black. When fully grown, they are about 1-½ inches long, whereas the southwestern corn borer is only about 1 inch in length. In maturing corn, the corn earworm feeds extensively on the ears, whereas the southwestern corn borer occasionally damages the ear.

Fall Armyworm: Fall armyworm larvae (Fig. 17) frequently feed on the leaves and in the stalk and ear shank, and damage the ear by feeding on the grain. The young larvae skeletonize the leaves, leaving conspicuous whitish patches when seen against the green parts of the leaf. When fully grown the larvae are striped, nearly naked, and almost 1-½ inches in length. Their color ranges from light green to almost black.

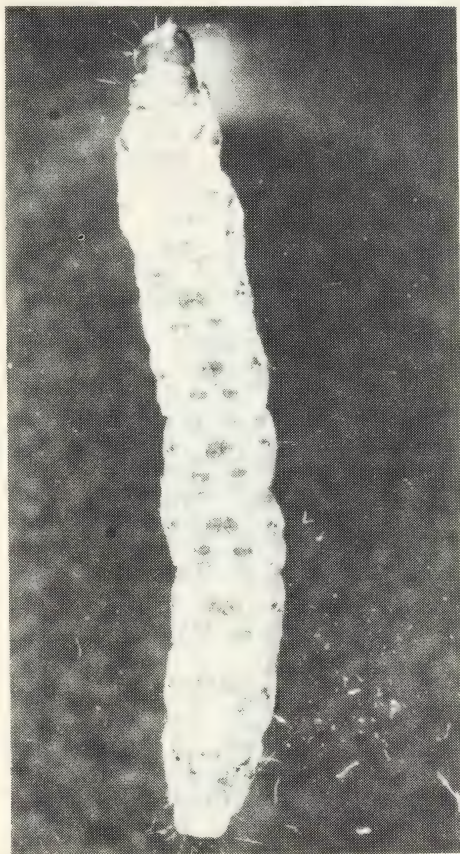


Figure 20. Sugarcane borer (Photo by Sugarcane Borer Research Laboratory, Houma, La., and Abner Hammond, Entomologist, L. S. U.)

They devour every leaf, leaving only the toughest parts of the plant stems.

Southern Cornstalk Borer: The larvae of this insect looks very much like the larvae of the southwestern corn borer (Fig. 18). They are about the same size and their color combinations are very similar. Damage to corn plants is almost identical to that of the southwestern, except the southern cornstalk borer does not girdle the stalk. Also, the southern corn stalk borer larvae have a summer form and a winter form, each closely resembling those of the southwestern.

European Corn Borer: Full-grown larva overwinter inside a tunnel in the corn stalk, stubble or ear of corn, or in weeds or other plant material. Almost 1 inch long with a dark brown or black head, and a gray to light brown or flesh-colored body, the larva has rows of brown spots and several brown or pink lines extending lengthwise (Fig. 19).

European corn borer damage is caused by the larvae feeding in and on various parts of the corn plant. Leaf feeding that results in the destruction of the leaf surface, sheath girdling, and breakage of the mid-ribs causes reduced yields.

Stalk tunneling is similar to that of the southwestern corn borer, except that it seldom tunnels down into the bottom of the stalk as is the case of the late season southwestern larvae. At time of tasseling European larvae tunneling in the tassel stems often causes the tassels to break over.

Sugarcane Borer: Although this borer is primarily a pest of sugarcane, it readily attacks corn. The sugarcane borer is similar to the southwestern corn borer and occurs along the gulf coast from Florida to the Mexican border.

The larva (Fig. 20) is about 1 inch

long when full-grown. It is yellowish white with brown spots. In the winter these spots are often absent and the color becomes a deeper yellow. Injury to the plant is caused only by the larvae. It tunnels inside the stalks, stunting the growth and sometimes killing young plants.

The sugarcane borer overwinters as a larva within a tunnel it has made in its host plant.

Figure 21 shows 4 of the above larvae with the southwestern corn borer larva on a common background for comparison of size and color patterns.

Summary

The southwestern corn borer has been found in 14 states with Central Alabama and Central Tennessee the most eastern points known to be infested.

This pest attacks all types of corn, sorghums, sugarcane, broomcorn, Sudangrass and Johnsongrass. Injury to the plant is caused exclusively by the larva.

Control of the southwestern corn borer may be achieved to some degree by early planting, cultural practices and by use and timing of insecticides. Early planting is best.

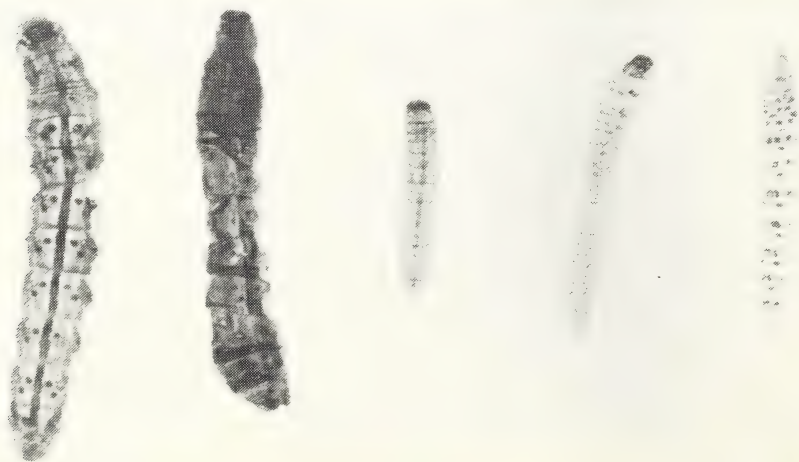


Figure 21. Corn earworm, fall armyworm, European corn borer, sugarcane borer, and southwestern corn borer (left to right).

Application of Soil Cement to Agriculture

By

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SUMMARY

Research results to date indicate that soil-cement may be applied economically and successively using equipment presently available on many farms in Mississippi. Some soils are not satisfactory for soil-cement application. Therefore, the area and soil must be carefully selected or a proven soil hauled in. The weather conditions found in this area certainly show the need for some type of economical hard surfacing for barn yards and feed lots. Soil-cement hard surface will stand up better under frequent wetting-drying than freezing-thawing. Some additives have proven advantageous when used with soil-cement.

Soil-cement can serve agriculture for feedlots, loafing areas, driveways, machinery stands, airstrips, parking, floors for farm buildings and in soil and water control.

For satisfactory results with soil-cement:

- (a) Select the areas carefully
- (b) Provide good management
- (c) Use ten percent cement
- (d) Do not use soil-cement under silage or immediately next to feed or water troughs, use concrete for these small areas.

SUMMARY FOR AVERAGE MONTHLY EVAPORATION, TEMPERATURE AND PRECIPITATION

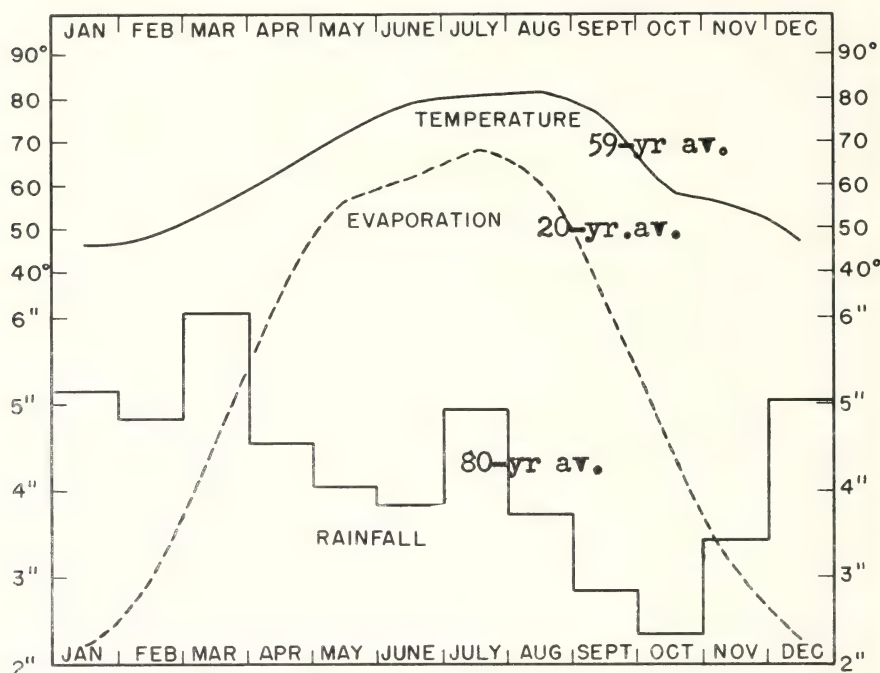


Figure 1. Average monthly evaporation, temperature and precipitation, State College, Miss.

Month	Pan Evaporation* In Inches	Temperature** In degrees			Precipitation*** In Inches
		Max.	Min.	Mean	
January	2.21	56.4	35.8	46.3	5.16
February	2.98	59.5	37.4	48.4	4.82
March	4.58	66.9	44.1	55.5	6.06
April	6.08	74.4	51.9	63.8	4.54
May	7.39	83.0	59.8	71.4	4.04
June	7.60	90.8	67.7	79.1	3.83
July	7.92	91.9	70.3	80.1	4.95
August	7.56	92.0	69.5	80.8	3.72
September	6.14	87.8	64.1	76.0	2.85
October	4.52	76.8	51.8	64.3	2.34
November	3.09	65.7	42.4	55.2	3.43
December	2.28	57.1	36.7	47.2	5.04
Average	5.19	75.2	52.6	64.0	50.70

*20-year average

**59-year average

***80-year average

BY THOMAS N. JONES

Mississippi receives an annual rainfall of 50.70 inches. Although the distribution does not please everyone, it is a tremendous asset to the State. This rainfall permits the livestock industry to contribute greatly to the economy of Mississippi — \$398,004,000 in 1966, an increase of 67,519,000 over 1965. A large portion of this increase was in the poultry division. Cotton lost \$138,961,000 and soybeans gained \$28,727,000 during the same period. In 1966, livestock and livestock products accounted for 50.8 percent of cash farm income in Mississippi (excluding Government payments).

In order to receive the greatest economical return from the livestock industry the producers must utilize the long growing season through a systems management plan for the production and feeding of quality forage. During the winter months the heavy rainfall (Figure 1) often causes meat animals to use far too much energy wading through boggy barnyards and feed lots. Energy requirements may be reduced 33 percent by putting dairy and beef animals on hard surface. Producers state that better feed efficiency of both beef and dairy animals will be obtained when they are fed on hard-surfaced or semi-hard-surfaced feed lots.

It has been estimated that hard surfacing a feedlot would reduce the cost of cleaning milk cows by one-third, and mas-

titis by an equal amount. The livestock industry is important to the economy of the state, and it is imperative that the efficiency of this industry be maintained at a high level.

Research was initiated to develop a practical and inexpensive method of surfacing feed lots. Concrete is satisfactory insofar as durability is concerned; however, the cost of concrete is often more than the farmer can justify in his operation. If the cost of hard-surfacing were reduced one-half or more, many farmers would benefit.

Soil-cement is defined as a mixture of pulverized soil and added material and cement. This well mixed portion of soil, and/or materials plus cement must be brought to a moisture content which will permit very high compaction. With excellent compaction and proper curing, a hard surface is formed which does not deteriorate readily if properly managed. Soil-cement has been in use for many years for highway sub-base. However applying it with equipment available for farm use is a new concept that could revolutionize hard surfacing in the agricultural area.

Soil-cement can serve agriculture for feedlots, loafing areas, driveways, machinery stands, airstrips, parking, floors for farm building and in soil and water control.

OBJECTIVES

The purpose of this study was to determine which of the native soils, when mixed with cement, will make a satisfactory hard surface for feed lots. The study was conducted in two phases:

1) A laboratory phase to develop engi-

neering criteria to be used in the design of hard-surfaced feed lots.

(2) Field in-place studies to evaluate various hard-surfacing materials which seem to show promise.

PROCEDURE

The laboratory phase was started first in order that the early results might be utilized in determining the materials and soil-cement ratios to be used in the field tests. The procedure used was the standard ASTM (American Society for Testing Materials) procedure. These test methods were: methods of test for moisture-density relations of soil-cement mixtures, ASTM D558-57; methods of wetting and drying test of compacting soil-cement mixtures, ASTM D559-57; methods of freezing and thawing test of compacted soil-cement mixtures, ASTM D560-57.

Materials tested under the above procedure must complete at least twelve cycles before being accepted for highway use. For feed lot hard surfacing, it may not be economical or necessary to seal the surface. Therefore, it becomes desirable to know the total number of cycles a core will complete in the wetting-drying and freezing-thawing laboratory tests, or how long they will last. To obtain this information, the following procedure was followed:

Four rates or percentages of cement were used in making 4" x 6" cores of

soil-cement mixtures. These cores contain 6, 8, 10, and 12 percent cement, respectively, with selected native soils and additives. Triplicate cores are made and tested as follows: (1) wetting-drying, (2) freezing-thawing, and (3) crushing.

The cores are made from air dried materials (room temperature), weighing and mixing enough material to make three cores from one batch. After the materials are weighed including soil, cement and additives, if any, this material is mixed dry. Vaporized water is then added and mixed until proper moisture content is obtained, moisture sample is taken to determine moisture. Cores are then molded in accordance with American Society for Testing Materials procedure. After the cores are removed from the molds they are cured for twenty-eight days in high humidity room. When the cores for one test have completed the curing process they are weighed and assigned to one of the three laboratory tests. With twelve soil types this gives us above 3200 probabilities. The cores are weighed each time they are moved thus the average moisture gained, the percent moisture gain and number of cycles are recorded.

LABORATORY STUDIES

The procedure for the wetting-drying tests is for the dry cores, after being weighed, to be placed in three inches of water for seven days, then removed from water, weigh the wet core and allow to air dry at room temperature for seven days. This completes the two week cycle and the moisture gained is determined.

The cores in the freezing-thawing studies are placed in three inches of water one week, one week in the freezer and one week drying so that they go through a three-week cycle.

After the cores have dried in both the freezing-thawing and wetting-drying test, the dry weight subtracted from the wet weight shows the amount of water in percent, absorbed during the soaking period. The amount of water absorbed by a core is usually directly proportional to the cement in the mixture although additives affect the amount of water soaked up.

Tables 3-13 show results of the laboratory study. Each table contains the pertinent data related to one soil type. Therefore, one soil may be studied or two

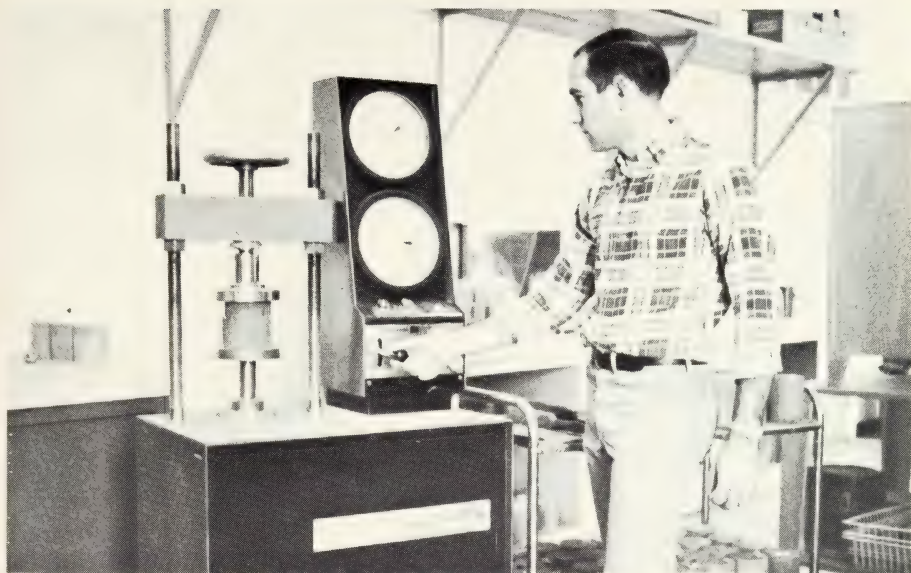


Figure II. Versa-tester Compression Testing Equipment.

or more soils may be compared as to their acceptable use with soil-cement. The most important items presented are (1) the data as compared to percent cement, (2) compressive strength (3) length of the test, (4) the number of cycles a core completed in the test. In the southeastern portion of the nation, freezing-thawing is not a major problem. Therefore, the wetting-drying and compressive strength on the various soil types found in this area are what concerns us in studying these data.

Results to date indicate that the freezing-thawing is more severe on the soil-cement hard surface than wetting-drying. What this means is that soil-cement hard surface will stand up better under climatic conditions found in the South.

So far, it seems that about any soil except clay may be used to make soil-cement. The Prairie section has Houston, Binnsville, and Brooksville soil types which are all heavy clays. The Delta area has Sharkey clay (buckshot) soil which is

a heavy clay. These clay soils are not satisfactory in a soil-cement mixture. Clay shrinks when it is dry and swells when it is wet, so it is difficult to make a good surface by mixing cement with this type soil. It is necessary to haul a suitable soil in if a satisfactory hard surface is desired on heavy clay areas.

The Prairie or Blackbelt area is found in Northeast Mississippi extending into Alabama. Houston is one of the major soil types with a clay, silt and colloidal content of approximately 75 percent. The soils found in the prairie are not satisfactory for use in soil-cement. Tests showed however, that a suitable soil could be hauled in and spread six inches deep and used for soil-cement entirely satisfactorily. This makes soil-cement more expensive in the heavy clay areas, but this is where the mud gives a lot of trouble. On field tests where a satisfactory soil was hauled in, and with proper management, results have been very good. In the laboratory tests Houston clay soil has not proven satisfactory. Table 3. However,

when ground rubber and fiberglass were added at rates of ten percent the results were much improved. The moisture gained while in water ranged from 32 percent with six percent cement and 20% sawdust as an additive down to 6.6 percent with twelve percent cement and twenty percent limestone as an additive.

To show just how poor the Houston clay cores performed in the laboratory tests only five cores out of 300 met the minimum requirements of twelve complete cycles, as set up by American Society for Testing Materials Procedure.

The loess belt or (wind blown soil) in Mississippi is found east of the Delta from Tennessee to Louisiana. This region contains some very productive yet extremely erosive soils. Two of the major soils found in this region are Grenada (Table 6) and Calloway (Table 7). These two soils proved very satisfactory in the laboratory tests. Many of the cores are still in the tests; complete data are not available for this publication.

One core with ten percent cement made from Calloway soil and in the wetting-drying test lasted through 121 complete cycles. This core would be good for fifteen years or more in the field. At the present time 55 cores in the wetting-drying test and 42 cores in the freezing-thawing test have passed the minimum requirement. The Calloway and Grenada are similar in mechanical analysis having 64.7 and 64.3 percent silt, 16.3 and 17.9 percent colloid, 15.8 and 16.1 percent sand respectively, with small amounts of clay. These soils are excellent for soil cement.

The Grenada soil is better drained but does not show up quite as well as the Calloway in the laboratory tests. The Grenada had 50 cores in wetting-drying and 26 cores in freeze-thawing that met the minimum requirement. The maximum gain in grams was 16.7 percent with minimum of 3.9 percent.

The Ora soil series (Table 8) is the ideal soil for use in soil-cement. The Ora soils are widely used in highway, streets, airfield runways, parking lots, etc. for sub-base stabilization. This soil is very erosive as you may guess from the mechanical analysis which shows a 70.2 percent sand, silt 14.1 clay 2.0, colloidal 13.7. The Ora series has a large number of cores remaining in the tests.

Pit run clay, sand, and gravel (Table 9) found in the streams makes one of the best materials for use with soil-cement. This material has been used over heavy clays and gives excellent results. The laboratory data shows that as the cores get older the amount of absorption increases slightly.

The soils found in the Delta do not hold up well in soil-cement applications. The heavy clays are unsatisfactory while the sandy loam does a poor job. (Table 12-13) These soils are not recommended for soil-cement.

Crushing: The equipment used for this study includes Versa-tester compression testing equipment (Soiltest, Inc.) Figure II and strain gauge transducers and appropriate amplifiers and a Servo-recorder for plotting stress as a function of strain. This recorder not only shows the compression curve to the upper limit but also records the curve or compression on the down or back side of the curve. The results obtained with the equipment have been entirely satisfactory.

The data show that the cores can be duplicated in the laboratory within reasonable accuracy.

The importance of soil type, cement and additives can be shown with the high and low figures from eleven laboratory crushing tests of more than 1400 cores. Ora sandy loam soil with 12% cement and 10% crushed limestone additive required 2962 pounds per square inch (PSI) for the highest figure and Ruston fine sandy

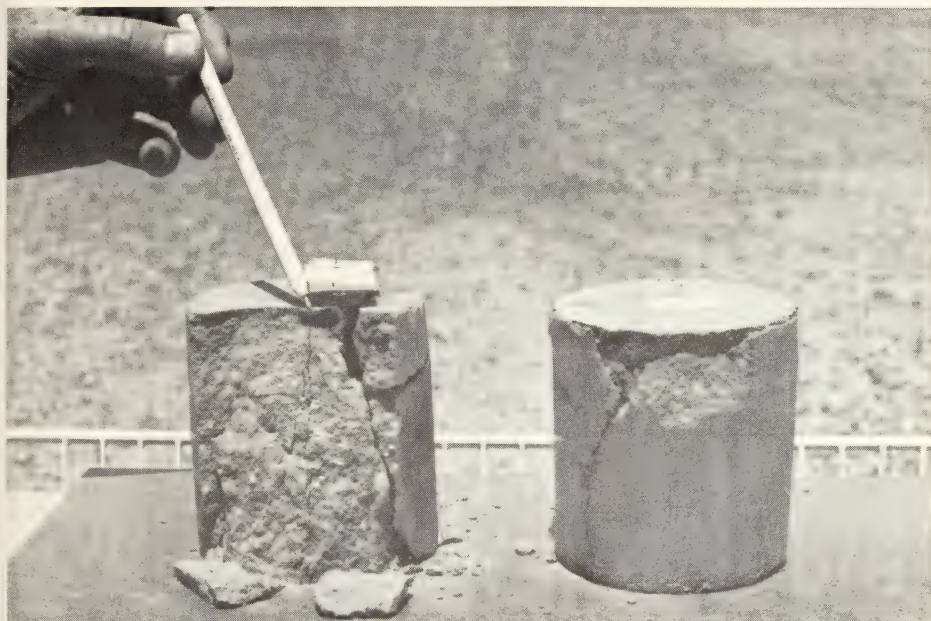


Figure III. Calloway silt loam with 8% cement (left) shattered at 256 pounds per square inch. Ora loam with 12% cement held to 1647 psi.

loam with 6% cement and 20% sawdust required 121 pounds per square inch (PSI) for the lowest figure. The crushing tests indicate very closely what the core will do in field tests. Figure III.

Figure IV shows three soils of the sandy loam series. The Ruston sandy loam found in the southern part of Mississippi ranged from 751 to 1500 pounds per square inch (PSI) required to crush the cores. Delta sandy loam ranged from 1150 to 1960 PSI required to crush the cores. Ora sandy loam ranged from 1155 to 2930 PSI required to crush the cores. The interesting thing in this comparison is the 8 percent cement which had a higher

PSI than the 10 percent cement with all three soils. The Ora sandy loam with 12 percent cement had the greatest strength of any soil tested.

Figure V compares three loam soils and one river run or pit run clay, sand-gravel. These are all good materials for use in soil cement although they do not compare with the Ora series which has proven superior in tests conducted. Figure VI compares three clay soils and limestone. Oktibbeha clay is by far the best of this series, with Sharkey being the poorest. Oktibbeha clay is the only one in this series that could be recommended and that would be with reservations.

FIELD STUDIES

During the summer of 1964, an in-place test was constructed for study of paved feed lots at the Black Belt Branch Experiment Station, Brooksville, Missis-

sippi. The laboratory studies had shown that the local Houston clay soil would not be satisfactory in a soil-cement mixture. Therefore, two soils (Ora loam and

FIGURE IV
COMPRESSIVE STRENGTH -- (PSI)

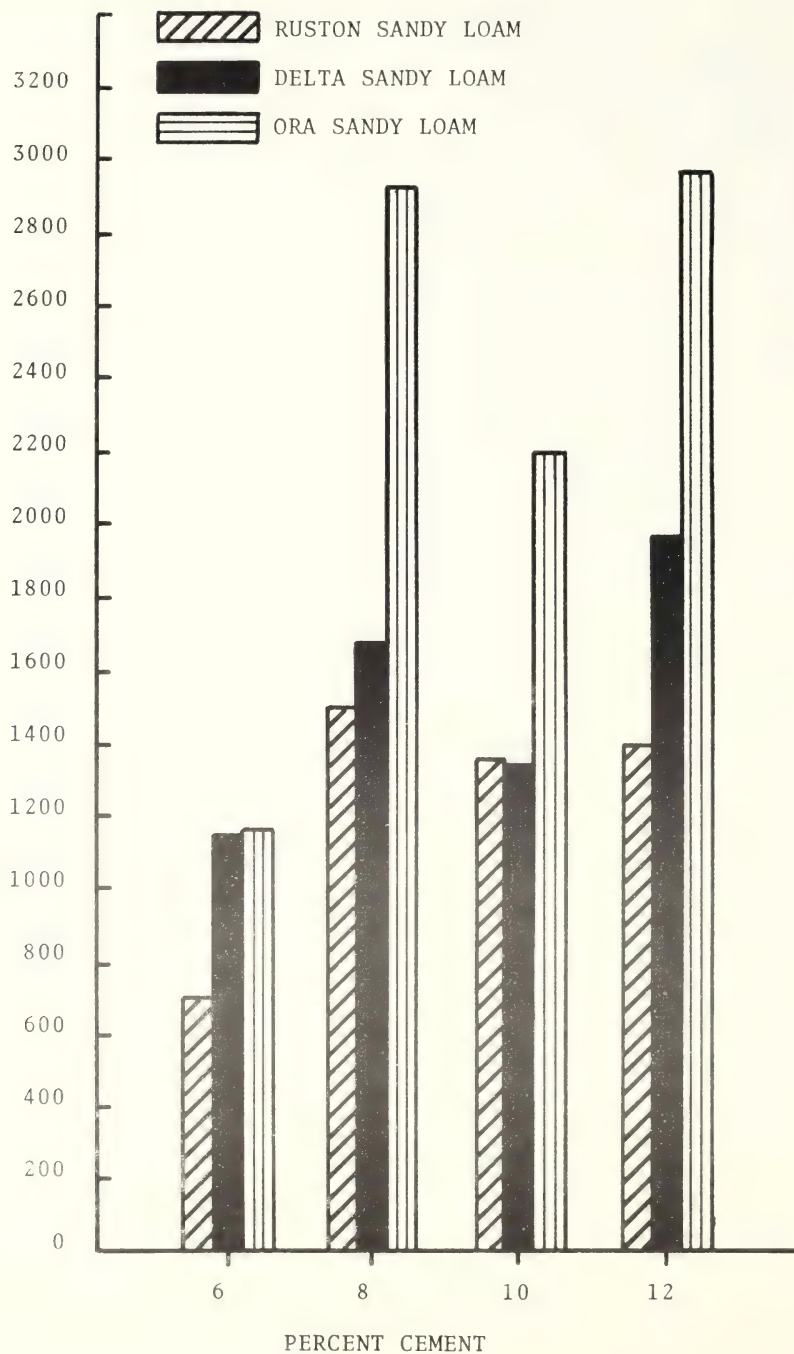


FIGURE V

COMPRESSIVE STRENGTH -- (PSI)

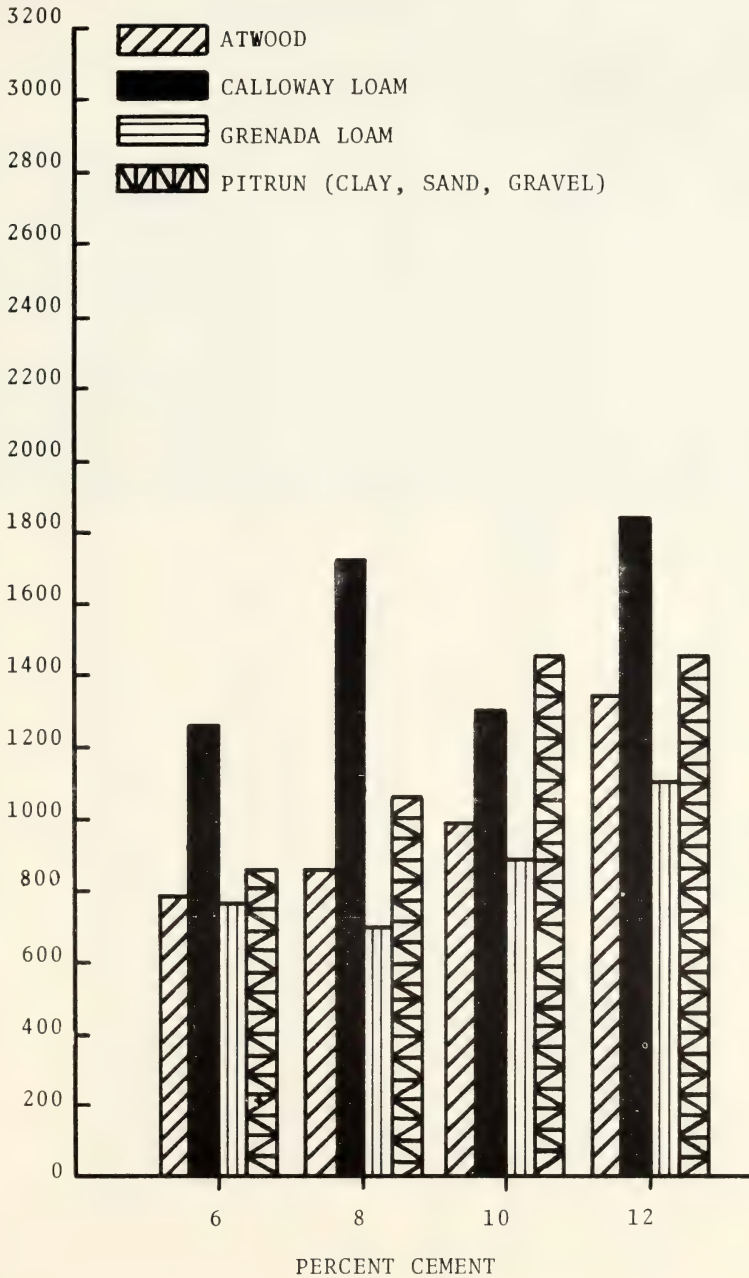


FIGURE VI
COMPRESSIVE STRENGTH -- (PSI)

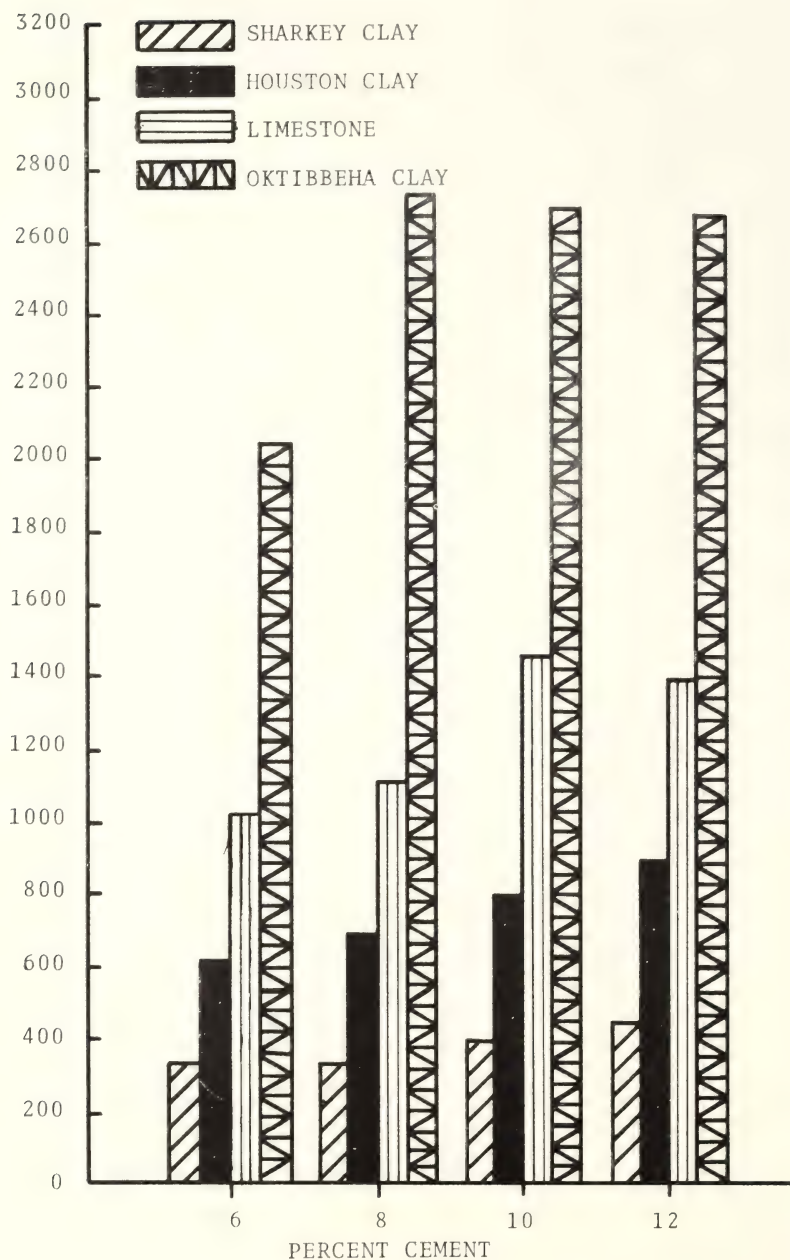




Figure VII. Dairy cows on soil-cement hard surfacing at Black Belt Experiment Station, Brooksville, Mississippi.

pit run sand-gravel available in the area) were hauled in and spread 6 inches thick over the test area. Then four rates of cement were used plus a lime application on a section of each soil-cement mixture. In addition, two plots of concrete using two thicknesses and reinforcement are being checked. This gives a total of twenty-one applications for study. Only such equipment as is available to farmers was used in constructing these plots. Dairy cows are being used to test these hard surfaces. Figure VII.

This test has been used four years and is still in excellent condition except the six percent cement plots which required minor repairs in 1968. If the soil-cement will last ten years, it would be an economical investment. The hard surface can be repaired, or it makes a wonderful base for another layer of soil-cement or concrete.

In 1965 another test was installed at the Black Belt Branch Station in which an

additive of ground rubber is being compared with no additive on two soil types and four rates of cement. This test is in excellent condition after three years.

Three field tests were installed at the North Mississippi Branch Experiment Station, Holly Springs, Mississippi on September, 1965. One test was put on each of three major soil types found in that area; namely, (1) Grenada, (2) Calloway, and (3) Lexington. Each test consists of an area 30' x 120'. This area was divided into 10' x 30' plots giving three replications for each of the four cement percentages used. The 30-foot width was selected so that troughs could be placed on the hard surface area and have enough space for a tractor and trailer to mechanically unload feed while the cows eat on the other side of the trough.

In 1966, additional tests were put in at Holly Springs. All tests at Holly

Springs have been entirely satisfactory except those with six percent cement.

Tests have also been installed at the main station State College, Mississippi and other Branch Experiment Stations. If soil-cement is to work satisfactory, good management practices must be carried out. The soil-cement must be cleaned off and given an opportunity to dry out, it cannot stand up under wet manure. Concrete will give better service around permanent feed troughs and water troughs where cattle are fed continuously. A twelve foot strip of concrete around troughs will be satisfactory and use soil-cement for the remaining area. Any area where soil-cement is applied should be well drained.

For the construction the following procedure was followed: (1) the vegetation was destroyed by disking the area twice a week for two weeks: (2) the area was staked off and divided into plots. The cement was placed on each plot and spread evenly over the plot by hand (hoe and rake).

Next, the cement and native soil were mixed several times using tractor-powered take-off-driven rotary tiller. The surface was smoothed with a section harrow and water was applied from a tank on the truck or trailer. The tractor-mounted rotary tiller continued to mix the soil-cement-water until moisture content reached approximately 15 to 18 percent. The section harrow was used again to smooth the surface and the area was rolled until compacted with a heavy roller. Table I shows the area one bag of cement will cover and the cost of cement per plot and per cubic yard. If the cost of labor and equipment were figured at the same amount for both soil-cement and concrete, we would be in a good position to compete with concrete. The soil-cement mixture costs 50 percent less than the cost of concrete.

Beef cattle are being fed on these test areas using tractors, and self-unloading trailers to handle the feed. Figure VII

Table 1. Cement and equipment requirements.

Per Cent Cement by Volume	One Bag of Cement Will Cover 6" Deep	Cost of Cement per Cu. Yd.
6%	33.33 sq. ft.	\$2.11
8%	25.00 sq. ft.	\$2.80
10%	20.00 sq. ft.	\$3.50
12%	16.66 sq. ft.	\$4.22

Water Requirement: Approximately one gallon per square foot of surface.

Equipment requirement:

1. Power take-off rotary tiller
2. Section harrow (lift-type)
3. Equipment for handling water
 - a. Trucks with tanks
 - b. Pump from nearby pond
 - c. Ample supply from water system
4. Roller (heavy)

Table 2. Mechanical Analysis of soils

Soil	Three Trials	Per Cent Sand	Per Cent Silt	Per Cent Clay	Per Cent Colloidal
Houston	Average	24.3	34.2	3.2	38.2
Calloway	Average	15.8	64.7	3.2	16.3
Grenada	Average	16.1	64.3	1.7	17.9
Ora Loam	Average	62.0	18.6	1.3	18.1
Ora Sand	Average	84.0	8.4	0.3	7.3
Ora Sandy Loam	Average	70.2	14.1	2.0	13.7
Ora Sandy Loam	Average	74.8	11.8	0.6	12.8
Limestone	Average	33.4	50.6	10.0	6.0
Delta Sandy Loam	Average	36.0	35.6	3.6	24.8
Ruston Fine Sandy Loam	Average	60.9	18.5	3.6	16.9
Delta Sharkey Clay	Average	20.2	32.9	4.8	42.1

Table 3. Studies of Hard Surfacing Materials With Houston Clay

Soil Type	Cement	Weight	Mois- ture Gain	Crush- ing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
	%	Grams	%	Lbs.	Months	Number		Cores	
Houston Clay	6	1652	15.1	533	60	2	1	0	0
	8	1666	11.2	605	60	4	3	0	0
	10	1696	9.1	728	60	3	3	0	0
	12	1704	9.1	883	60	5	2	0	0
Houston 33.3% Rubber	6	1449	17.1	239	60	10	8	0	0
	8	1451	14.6	277	60	20	11	0	0
	10	1415	12.8	293	60	10	11	0	0
	12	1523	13.5	377	60	11	2	0	0
Houston 5% Rubber	6	1405	16.0	250	36	2	3	0	0
	8	1453	13.2	310	36	3	2	0	0
	10	1461	11.1	374	36	8	5	0	0
	12	1438	13.6	307	36	8	5	0	0
Houston 10% Rubber	6	1465	11.4	308	36	4	3	0	0
	8	1540	8.5	348	36	5	8	0	0
	10	1532	11.2	430	36	3	7	0	0
	12	1577	9.0	456	36	9	3	0	0
Houston 10% Rubber	6	1526	12.1	326	36	4	4	0	0
	8	1562	9.0	345	36	5	8	0	0
	10	1522	8.8	363	36	5	8	0	0
	12	1554	9.2	435	36	5	4	0	0
Houston 5% Fiber-glass	6	1435	17.5	400	24	8	5	0	0
	8	1430	16.0	550	24	11	5	0	0
	10	1471	13.9	487	24	14	5	0	0
	12	1460	13.9	573	24	26	16	0	0
Houston 10% Fiber-glass	6	1501	13.3	428	24	5	8	0	0
	8	1533	10.6	589	24	5	8	0	0
	10	1495	12.2	766	24	5	8	0	0
	12	1440	16.4	587	24	36	9	0	0
Houston 20% Fiber-glass	6	1447	17.6	565	24	4	5	0	0
	8	1542	13.4	654	24	11	6	0	0
	10	1479	12.0	582	24	11	9	0	0
	12	1521	15.3	517	24	11	9	0	0
Houston 5% Lime-stone	6	1645	10.3	510	18	2	1	0	0
	8	1710	6.6	661	18	2	1	0	0
	10	1695	9.6	613	18	6	2	0	0
	12	1716	8.6	748	18	10	2	0	0
Houston 10% Lime-stone	6	1638	13.9	432	18	1	1	0	0
	8	1677	8.8	637	18	2	1	0	0
	10	1654	7.4	624	18	3	2	0	0
	12	1652	7.6	669	18	3	2	0	0
Houston 20% Lime-stone	6	1732	11.2	621	18	3	2	0	0
	8	1726	7.3	693	18	6	3	0	0
	10	1778	7.4	796	18	10	9	0	0
	12	1767	6.6	669	18	20	15	0	0
Houston 5% Sawdust	6	1392	16.4	550	12	2	3	0	0
	8	1385	14.5	687	12	5	4	0	0
	10	1367	13.6	696	12	6	4	0	0
	12	1437	12.8	785	12	7	5	0	0
Houston 10% Sawdust	6	1254	18.1	572	12	5	4	0	0
	8	1308	14.3	515	12	5	4	0	0
	10	1238	15.3	618	12	6	4	0	0
	12	1295	14.2	820	12	9	7	0	0
Houston 20% Sawdust	6	959	32.0	309	12	4	3	0	0
	8	995	22.3	403	12	9	4	0	0
	10	940	21.8	334	12	9	4	0	0
	12	1023	23.3	309	12	9	7	0	0

Table 4. Studies of Hard Surfacing Materials With Limestone

Soil Type	Cement	Weight	Moisture Gain	Crushing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
	%	Grams	%	Lbs.	Months	Number		ores	
Lime-stone	6	1602	15.1	697	51	2	2	0	0
	8	1633	8.6	963	51	10	1	0	0
	10	1685	8.8	987	51	14	1	0	0
	12	1736	8.5	1218	51	30	13	0	0
Lime-stone 33.3% Rubber	6	1464	12.9	330	43	62	12	0	0
	8	1455	9.7	349	43	62	23	0	0
	10	1506	9.2	419	43	86	24	0	0
	12	1550	9.2	546	43	86	36	0	0
Lime-stone 10% Rubber	6	1412	11.8	490	36	21	8	0	0
	8	1438	10.3	475	36	47	13	0	0
	10	1430	5.5	509	36	47	13	0	0
	12	1420	9.5	510	36	47	24	0	0
Lime-stone 20% Rubber	6	1395	13.2	419	36	36	8	0	0
	8	1391	11.0	481	36	45	13	0	0
	10	1396	10.7	428	36	47	13	0	0
	12	1414	10.5	548	36	47	25	0	0
Lime-stone 10% Fi- berglass	6	1389	14.5	521	36	8	8	0	0
	8	1362	13.9	679	36	47	13	0	0
	10	1383	8.5	674	36	48	13	0	0
	12	1403	11.6	897	36	71	13	0	0
Lime-stone 20% Fi- berglass	6	1359	19.3	737	36	47	13	0	0
	8	1408	16.2	741	36	48	13	0	0
	10	1379	16.4	874	36	71	13	0	0
	12	1377	18.2	959	36	62	21	0	0
Lime-stone 5% Rubber	6	1422	14.0	357	25	13	3	0	0
	8	1386	12.5	441	25	10	5	0	0
	10	1431	11.0	272	25	8	5	0	0
	12	1486	13.8	274	25	8	5	0	0
Lime-stone 5% Fi- berglass	6	1462	18.5	1020	25	18	11	0	0
	8	1404	16.6	1107	25	20	12	0	0
	10	1436	16.3	1100	25	18	16	0	0
	12	1458	16.8	1386	25	25	16	0	0
Lime-stone 5% Lime- stone	6	1482	16.1	621	13	6	2	0	0
	8	1572	12.9	788	13	13	9	0	0
	10	1582	12.4	804	13	13	15	0	0
	12	1568	15.1	860	13	13	9	0	0
Lime-stone 10% Lime- stone	6	1567	14.7	1011	13	10	7	0	0
	8	1596	9.4	1099	13	25	16	0	0
	10	1625	5.6	1449	13	27	19	0	0
	12	1638	8.6	1234	13	25	16	0	0
Lime-stone 20% Lime- stone	6	1633	10.6	796	13	24	5	0	0
	8	1607	10.2	717	13	27	15	0	0
	10	1656	8.5	1067	13	27	18	0	0
	12	1734	4.6	1298	13	30	20	0	1
Lime-stone 5% Sawdust	6	1363	15.2	645	6	6	3	0	0
	8	1389	9.3	717	6	9	4	0	0
	10	1417	7.9	908	6	13	7	0	0
	12	1427	9.6	892	6	13	8	0	0
Lime-stone 10% Saw- dust	6	1231	17.4	497	6	7	2	0	0
	8	1253	14.3	612	6	11	4	0	0
	10	1254	13.0	731	6	14	7	0	0
	12	1274	13.1	876	6	14	2	1	0
Lime-stone 20% Saw- dust	6	1004	25.0	424	6	5	2	0	0
	8	1020	16.0	425	6	6	3	0	0
	10	1041	16.2	526	6	14	5	0	0
	12	1042	18.8	489	6	14	7	0	0

Table 5. Studies of Hard Surfacing Materials with Oktibbeha Clay

Soil Type	Cement %	Weight Grams	Moisture Gain %	Crushing PSI Lbs.	Test Length Months	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
						Number		Cores	
Oktibbeha Clay	6	1777	8.9	1011	13	3	2	0	0
5%	8	1652	11.9	502	13	3	2	0	0
Limestone	10	1731	9.8	987	13	3	2	0	0
	12	1631	11.1	581	13	3	5	0	0
Oktibb. Clay	6	1755	11.7	497	13	3	2	0	0
10%	8	1738	10.8	764	13	3	2	0	0
Limestone	10	1786	9.5	892	13	3	2	0	0
	12	1751	9.4	836	13	3	2	0	0
Oktibb. Clay	6	1724	10.3	467	13	3	2	0	0
20%	8	1836	7.4	860	13	6	7	0	0
Limestone	10	1858	5.8	900	13	7	7	0	0
	12	1835	5.5	1011	13	11	7	0	0
Oktibb. Clay	6	1618	14.7	502	12	2	1	0	0
	8	1709	10.5	796	12	2	2	0	0
	10	1736	8.2	995	12	3	4	0	0
	12	1704	8.1	764	12	3	4	0	0
Oktibb. Clay	6	1371	11.9	199	12	8	4	0	0
	8	1404	7.2	192	12	6	4	0	0
33.3%	10	1325	10.0	234	12	8	9	0	0
	12	1373	7.9	231	12	8	6	0	0
Oktibb. Clay	6	1742	7.4	334	12	5	4	0	0
	8	1738	5.9	509	12	8	5	0	0
5%	10	1676	6.3	447	12	8	6	0	0
Rubber	12	1616	11.2	384	12	7	11	0	0
Oktibb. Clay	6	1594	18.2	982	12	18	10	0	0
5%	8	1728	9.8	1361	12	28	18	0	0
Fiber-glass	10	1659	10.3	1107	12	28	17	1	0
	12	1663	9.5	1321	12	28	15	0	0
Oktibbeha Clay	6	1592	13.2	264	12	10	9	0	0
	8	1632	8.4	326	12	12	9	0	0
10%	10	1683	9.0	296	12	14	12	0	0
Rubber	12	1595	8.8	320	12	15	13	0	0
Oktibb. Clay	6	1595	17.1	2038	12	14	10	0	0
10%	8	1629	12.0	1696	12	27	15	0	0
Fiber-glass	10	1537	10.0	1616	12	28	17	1	0
	12	1633	9.7	1879	12	28	15	1	0
Oktibb. Clay	6	1499	11.4	207	12	6	4	0	0
	8	1566	10.3	223	12	19	13	0	0
20%	10	1597	7.6	232	12	18	12	0	0
Rubber	12	1604	7.3	247	12	19	15	0	0
Oktibb. Clay	6	1592	17.3	1632	12	22	10	0	0
20%	8	1635	15.8	2739	12	22	13	0	0
Fiber-glass	10	1655	11.2	2683	12	27	16	0	0
	12	1629	12.4	2659	12	28	17	1	0
Oktibb. Clay	6	1508	12.9	419	6	11	7	1	0
5%	8	1547	8.9	530	6	14	8	1	0
Sawdust	10	1551	5.9	559	6	14	10	1	0
	12	1559	5.9	618	6	14	10	1	1
Oktibb. Clay	6	1329	14.8	398	6	9	5	1	0
10%	8	1314	11.9	465	6	14	8	1	0
Sawdust	10	1329	10.3	481	6	14	8	1	0
	12	1418	9.3	526	6	14	10	1	0
Oktibb. Clay	6	1098	21.3	187	6	9	3	1	0
20%	8	1166	17.7	183	6	14	4	1	0
Sawdust	10	1222	13.5	279	6	14	9	1	0
	12	1251	18.1	231	6	14	7	1	0

Table 6. Studies of Hard Surfacing Materials With Grenada Clay

Soil Type	Cement	Weight	Moisture Gain	Crushing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
						Number			Cores
Grenada	6	1513	14.2	128	63	22	11	0	0
33.3%	8	1538	12.8	129	63	68	13	0	0
Rubber	10	1532	12.6	175	63	118	41	1	0
	12	1557	12.2	455	63	118	41	1	0
Grenada	6	1668	11.6	430	51	10	8	0	0
	8	1648	11.7	485	51	95	9	0	0
	10	1720	9.5	836	51	95	9	0	0
	12	1670	4.9	762	51	100	59	1	0
Grenada	6	1517	13.1	233	36	47	8	0	0
10%	8	1525	11.3	248	36	74	13	0	0
Rubber	10	1486	9.2	244	36	76	32	0	0
	12	1513	11.3	252	36	77	32	1	0
Grenada	6	1482	12.7	182	36	47	13	0	0
20%	8	1451	11.6	189	36	71	13	0	0
Rubber	10	1447	10.0	203	36	71	13	0	0
	12	1399	11.0	174	36	71	32	0	0
Grenada	6	1519	12.4	184	36	47	12	0	0
10%	8	1480	5.7	329	36	77	13	1	0
Fiber-	10	1452	6.6	320	36	76	32	0	0
glass	12	1593	9.8	651	36	77	32	1	0
Grenada	6	1664	12.1	769	25	77	22	0	0
20%	8	1588	3.9	702	25	77	32	1	0
Fiber-	10	1661	5.5	823	25	77	32	1	0
	12	1646	6.0	763	25	77	32	1	0
Grenada	6	1500	14.8	106	25	20	3	0	0
5%	8	1514	13.2	277	25	50	4	0	0
Rubber	10	1504	11.6	387	25	50	16	0	0
	12	1535	12.5	597	25	50	10	1	0
Grenada	6	1528	14.9	374	25	23	13	1	0
5%	8	1466	13.9	224	25	52	12	1	0
Fiber-	10	1526	11.2	451	25	55	16	1	0
	12	1468	15.6	314	25	55	16	1	0
Grenada	6	1607	15.5		18	4	1	0	0
Subsoil	8	1595	12.5		18	20		0	0
	10	1591	11.1		18	11		0	0
	12	1566	13.1		18	34		0	0
Grenada	6	1627	11.1	282	13	5	3	0	0
5%	8	1667	10.4	354	13	5	3	0	0
Lime-	10	1685	8.1	492	13	23	14	0	0
stone	12	1663	8.6	669	13	23	18	0	0
Grenada	6	1669	12.6	463	13	27	7	0	0
10%	8	1703	10.0	479	13	27	15	0	0
Lime-	10	1736	7.5	892	13	25	18	0	0
stone	12	1725	7.5	1107	13	30	18	1	0
Grenada	6	1707	10.7	343	13	27	10	0	0
20%	8	1719	7.1	482	13	30	20	1	0
Lime-	10	1816	6.1	581	13	30	20	1	0
stone	12	1625	7.7	549	13	30	20	1	1
Grenada	6	1430	13.5	241	6	9	3	0	0
5%	8	1369	12.0	207	6	11	4	0	0
Sawdust	10	1400	8.1	277	6	14	7	1	0
	12	1431	8.1	376	6	14	10	1	1
Grenada	6	1262	17.9	239	6	11	3	0	0
10%	8	1274	14.5	258	6	14	3	0	0
Sawdust	10	1286	12.5	346	6	14	5	1	0
	12	1378	10.7	360	6	11	8	1	1
Grenada	6	1277	15.8	320	6	14	7	1	0
20%	8	1011	24.5	204	6	11	2	0	0
Sawdust	10	986	22.9	244	6	14	3	0	0
	12	1053	20.1	341	6	14	10	1	0

Table 7. Studies of Hard Surfacing Materials With Calloway Clay

Soil Type	Cement	Weight	Mois- ture Gain	Crush- ing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
	%	Grams	%	Lbs.	Months	Number		Cores	
Calloway	6	1696	11.2	278	63	66	11	0	0
	8	1698	12.0	256	63	95	15	0	0
	10	1736	11.7	444	63	118	16	0	0
	12	1682	12.1	503	63	121	29	0	0
Calloway 33.3% Rubber	6	1486	14.6	134	63	17	11	0	0
	8	1936	12.5	188	63	49	13	0	0
	10	1528	12.0	183	63	100	28	0	0
	12	1544	11.0	275	63	100	32	0	0
Calloway 10% Rubber	6	1500	12.2	161	36	47	12	0	0
	8	1497	7.7	223	36	77	13	0	0
	10	1884	7.7	305	36	71	19	0	0
	12	1564	8.2	436	36	77	32	1	0
Calloway 20% Rubber	6	1514	12.1	156	36	77	13	1	0
	8	1515	9.0	262	36	74	13	0	0
	10	1487	9.2	239	36	71	13	0	0
	12	1502	8.9	474	36	77	32	1	0
Calloway 10% Fiber- glass	6	1460	9.1	262	36	47	13	0	0
	8	1477	6.4	350	36	76	13	0	0
	10	1513	4.9	365	36	77	32	1	0
	12	1554	5.3	486	36	77	32	1	0
Calloway 20% Fiber- glass	6	1529	10.6	354	36	47	13	0	0
	8	1512	8.4	463	36	76	13	0	0
	10	1552	9.6	595	36	77	32	1	0
	12	1552	9.6	618	36	77	32	1	0
Calloway 5% Rubber	6	1483	16.3	200	25	20	8	0	0
	8	1517	12.1	330	25	35	16	0	0
	10	1578	10.1	517	25	55	16	0	0
	12	1534	13.0	294	25	50	16	0	0
Calloway 5% Fiber- glass	6	1586	16.2	1259	25	55	23	0	0
	8	1604	13.4	1721	25	55	32	0	0
	10	1648	12.3	1147	25	55	32	1	0
	12	1603	12.8	1832	25	34	1		0
Calloway 5% Lime- stone	6	1692	13.1	304	13	29	13	0	0
	8	1700	11.0	725	13	30	15	1	0
	10	1668	6.1	677	13	30	19	1	0
	12	1684	6.4	701	13	30	20	1	1
Calloway 10% Lime- stone	6	1587	8.3	201	13	30	15	0	0
	8	1572	5.8	272	13	30	18	1	0
	10	1619	5.4	438	13	30	20	1	1
	12	1704	8.4	844	13	30	20	1	1
Calloway 20% Lime- stone	6	1732	11.3	455	13	25	7	0	0
	8	1741	6.7	430	13	30	20	0	0
	10	1719	4.5	589	13	30	20	1	1
	12	1814	3.2	1258	13	30	20	1	1
Calloway 5% Sawdust	6	1382	13.9	188	6	14	5	0	0
	8	1411	8.7	257	6	14	10	1	0
	10	1439	6.0	432	6	14	10	1	1
	12	1461	8.5	433	6	14	10	1	1
Calloway 10% Sawdust	6	1233	18.2	170	6	14	5	0	0
	8	1269	11.5	314	6	14	10	1	0
	10	1213	11.6	166	6	14	5	0	1
	12	1268	12.3	381	6	14	10	1	1
Calloway 20% Sawdust	6	1010	30.0	156	6	6	10	0	0
	8	990	19.3	125	6	7	3	0	0
	10	1007	17.2	151	6	14	8	0	0
	12	1063	17.7	296	6	14	5	1	1

Table 8. Studies of Hard Surfacing Materials With Ora Sandy Clay

Soil Type	Cement	Weight	Mois- ture Gain	Crush- ing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
	%	Grams	%	Lbs.	Months	Number		Cores	
Ora Sandy	6	1581	13.1	279	54	36	20	0	0
Loam 33.3%	8	1623	11.3	385	54	89	20	0	0
Rubber	10	1589	9.8	415	54	92	36	1	0
	12	1612	6.5	535	54	110	36	1	1
Ora Sandy	6	1739	11.3	1106	51	100	59	0	0
Loam	8	1810	8.7	1082	51	100	60	1	0
	10	1846	7.3	1337	51	100	62	1	1
	12	1830	7.6	1647	51	100	62	1	1
Ora	6	1659	11.5	365	36	77	31	1	0
Sandy	8	1717	6.8	444	36	77	32	1	0
Loam 10%	10	1727	6.0	578	36	77	48	1	0
Rubber	12	1722	7.2	552	36	77	50	1	0
Ora	6	1624	10.6	218	36	74	25	0	0
Sandy	8	1678	7.7	360	36	77	32	0	0
Loam 20%	10	1717	6.5	617	36	77	47	1	0
Rubber	12	1799	7.4	608	36	77	50	1	1
Ora Sandy	6	1680	11.0	467	36	74	32	0	0
Loam 10%	8	1678	8.8	812	36	77	50	1	0
Fiberglass	10	1716	7.8	954	36	77	50	1	0
	12	1798	6.4	1286	36	77	50	1	0
Ora Sandy	6	1655	11.6	715	36	77	47	1	0
Loam 20%	8	1677	10.1	560	36	77	48	1	0
Fiber- glass	10	1706	7.3	1079	36	77	50	1	1
	12	1786	7.3	1544	36	77	50	1	1
Ora Sandy	6	1717	12.9	268	25	55	16	0	0
Loam 5%	8	1736	11.1	473	25	55	33	0	0
Rubber	10	1721	10.1	698	25	55	36	1	1
	12	1767	9.0	773	25	55	36	1	0
Ora Sandy	6	1698	12.7	622	25	55	33	1	0
Loam 5%	8	1688	10.3	800	25	55	34	1	0
Fiberglass	10	1744	8.0	1211	25	55	36	1	1
	12	1780	7.5	1402	25	55	36	1	1
Ora Sandy	6	1886	7.5	1083	13	30	18	1	1
Loam 5%	8	1910	5.2	2930	13	30	20	1	1
Limestone	10	1948	4.1	2197	13	30	20	1	1
	12	1944	4.1	2213	13	30	20	1	1
Ora Sandy	6	1909	6.3	1162	13	30	20	1	1
Loam 10%	8	1927	5.0	1680	13	30	20	1	1
Limestone	10	1974	4.2	1959	13	30	20	1	1
	12	1986	3.3	2962	13	30	20	1	1
Ora Sandy	6	1937	6.5	1115	13	30	20	1	1
Loam 20%	8	1945	5.2	1298	13	30	20	1	1
Limestone	10	2019	3.7	1720	13	30	20	1	1
	12	2041	3.8	2564	13	30	20	1	1
Ora Sandy	6	1544	14.1	382	6	14	10	1	1
Loam 5%	8	1603	8.4	607	6	14	10	1	1
Sawdust	10	1597	7.8	655	6	14	10	1	1
	12	1568	10.0	720	6	14	10	1	1
Ora Sandy	6	1311	19.3	206	6	14	8	1	1
Loam 10%	8	1314	15.5	298	6	14	10	1	1
Sawdust	10	1331	12.5	364	6	14	10	1	1
	12	1378	14.1	419	6	14	10	1	1
Ora Sandy	6	937	35.9	104	6	4	2	0	0
Loam 20%	8	945	28.4	117	6	9	7	0	0
Sawdust	10	974	25.2	127	6	9	5	0	0
	12	942	32.1	186	6	9	10	0	0

Table 9. Studies of Hard Surfacing Materials With Pit Run Sand Gravel

Soil Type	Cement	Weight	Moisture Gain	Crushing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
	%	Grams	%	Lbs.	Months	Number		Cores	
Pit Run	6	1959	5.3		63	124	79	1	0
Sand	8	2001	6.0		63	124	84	1	1
Gravel	10	2045	3.7		63	124	84	1	1
	12	2042	3.3		63	124	84	1	1
Pit Run	6	1758	8.1	239	63	124	66	1	0
Sand Gravel	8	1902	5.7	379	63	124	84	1	0
33.3% Rubber	10	1822	5.7	447	63	124	84	1	0
	12	1873	3.8	430	63	124	84	1	1
Pit Run	6	1724	8.2	92	36	4	8	0	0
Sand Gravel	8	1818	6.9	332	36	74	50	0	0
33.3% Rubber	10	1808	6.1	476	36	74	50	0	0
	12	1879	3.9	495	36	74	50	0	0
Pit Run	6	1864	4.4	179	36	75	50	0	0
Sand Gravel	8	1792	4.9	264	36	74	49	0	0
10% Rubber	10	1798	5.6	331	36	71	49	0	0
	12	1756	7.7	324	36	71	31	0	0
Pit Run	6	1776	7.5	402	36	76	32	0	0
Sand 10% Fiberglass	8	1865	4.7	841	36	77	52	0	0
	10	1912	3.9	1103	36	77	52	1	0
	12	1940	3.7	1341	36	77	52	1	1
Pit Run	6	1830	6.7	672	36	71	50	0	0
Sand Gravel	8	1806	5.3	649	36	71	50	0	0
20% Fiberglass	10	1926	3.2	1270	36	76	52	0	1
	12	1933	3.8	1453	36	77	52	1	1
Pit Run	6	1806	8.2	413	25	50	33	0	0
Sand	8	1835	6.4	582	25	55	34	0	0
Gravel 5% Rubber	10	1902	4.9	856	25	55	36	0	0
	12	1890	4.2	656	25	55	36	0	0
Pit Run	6	1820	7.1	884	25	50	34	0	0
Sand	8	1859	5.8	1060	25	55	36	1	0
Gravel 5% Fiberglass	10	1860	6.0	1450	25	55	36	1	1
	12	1881	5.1	1308	25	55	36	1	1

Table 10. Studies of Hard Surfacing Materials With Ruston Fine Sandy Loam

Soil Type	Cement	Weight	Mois- ture Gain	Crush- ing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
	%	Grams	%	Lbs.	Months	Number		Cores	
Ruston Fine	6	1536	11.8	69	36	19	12	0	0
Sandy Loam	8	1572	9.7	114	36	71	32	0	0
10% Rubber	10	1615	8.1	105	36	74	46	0	0
	12	1619	8.9	248	36	77	48	1	0
Ruston Fine	6	1564	10.4	123	36	47	6	0	0
Sandy Loam	8	1597	10.8	160	36	74	25	0	0
20% Rubber	10	1623	8.8	192	36	71	31	0	0
	12	1661	8.7	203	36	71	47	0	0
Ruston Fine	6	1624	11.6	343	36	74	31	0	0
Sandy Loam	8	1725	7.6	451	36	76	37	0	0
10% Fiber- glass	10	1702	8.1	540	36	76	50	0	0
	12	1685	9.5	519	36	77	50	1	0
Ruston Fine	6	1653	11.8	500	36	71	34	0	0
Sandy Loam	8	1644	9.1	489	36	76	37	0	0
20% Fiber- glass	10	1686	9.2	656	36	77	50	1	0
	12	1669	10.3	657	36	77	50	1	0
Ruston 5% Rubber	6	1704	10.7	205	25	55	16	0	0
	8	1678	8.3	255	25	55	23	0	0
	10	1642	7.0	301	25	55	34	0	0
	12	1704	5.8	470	25	55	36	0	1
Ruston 5% Fiberglass	6	1675	12.5	701	25	55	31	0	0
	8	1724	9.7	1506	25	55	36	0	0
	10	1739	9.6	1354	25	55	36	0	0
	12	1740	9.2	1392	25	55	36	0	1
Ruston	6	1794	9.8	443	18	39	23	1	0
	8	1767	8.5	430	18	39	23	1	0
	10	1842	6.9	833	18	39	25	1	1
	12	1830	6.4	841	18	39	25	1	1
Ruston	6	1733	7.1	228	13	30	20	0	1
Sandy Loam.	8	1873	6.4	549	13	30	20	1	1
5% Lime- stone	10	1814	5.1	416	13	30	20	1	1
	12	1904	4.9	693	13	30	20	1	1
Ruston	6	1868	8.2	462	13	30	20	1	1
Sandy	8	1841	5.5	482	13	30	20	1	1
Loam 10%	10	1842	5.1	756	13	30	20	1	1
Limestone	12	1838	5.1	693	13	30	16	1	1
Ruston	6	1854	8.6	349	13	30	20	1	1
Sandy Loam	8	1843	4.1	661	13	30	20	1	1
20%	10	1872	3.5	518	13	30	20	1	1
Limestone	12	1894	3.2	685	13	30	20	1	1
Ruston	6	1558	9.3	183	6	14	10	1	1
Sandy Loam	8	1568	5.7	257	6	14	10	1	1
5%	10	1604	4.9	459	6	14	10	1	1
Sawdust	12	1588	7.3	382	6	14	10	1	1
Ruston	6	1309	16.4	151	6	14	10	1	0
Sandy Loam	8	1349	12.9	187	6	14	10	1	1
10%	10	1341	10.6	217	6	14	10	1	1
Sawdust	12	1402	13.0	269	6	14	10	1	1
Ruston	6	976	37.3	121	6	5	7	0	0
Sandy Loam	8	1058	27.1		6	11	4	0	0
20%	10	1094	23.8	140	6	14	7	1	0
Sawdust	12	1154	22.3		6	9	6	1	0

Table 11. Studies of Hard Surfacing Materials With Atwood Silt Loam

Soil Type	Cement	Weight	Mois- ture Gain	Crush- ing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
	%	Grams	%	Lbs.	Months	Number		Cores	
Atwood	6	1771	11.0	751	18	34	1	0	0
Silt Loam	8	1694	13.5	457	18	12	1	0	0
Subsoil	10	1745	9.4	581	18	14	1	0	0
	12	1715	11.4	546	18	14	1	0	0
Atwood	6	1805	9.9	796	13	25	8	0	0
Silt Loam	8	1861	7.0	756	13	27	15	0	0
5%	10	1806	6.3	987	13	27	18	0	0
Limestone	12	1874	6.0	1019	13	30	18	0	0
Atwood	6	1882	9.5	549	13	27	9	0	0
Silt Loam	8	1803	7.0	860	13	27	15	0	0
10%	10	1894	6.0	876	13	27	16	0	0
Limestone	12	1895	5.9	1338	13	27	18	0	0
Atwood	6	1798	10.2	613	13	27	11	0	0
Silt Loam	8	1895	7.5	701	13	30	16	0	0
20%	10	1877	5.6	876	13	30	20	1	0
Limestone	12	1893	5.9	1131	13	30	20	1	0
Atwood	6	1724	10.3	577	6	14	7	0	0
Silt Loam	8	1693	6.6	717	6	14	8	0	0
5%	10	1638	6.8	797	6	14	10	1	0
Sawdust	12	1626	7.2	976	6	14	10	1	0
Atwood	6	1449	13.7	359	6	14	7	1	0
Silt	8	1508	8.3	558	6	14	10	1	0
Loam 10%	10	1404	10.8	632	6	14	10	1	0
Sawdust	12	1495	9.3	626	6	14	10	1	0
Atwood	6	1211	20.2	355	6	14	5	0	0
Silt	8	1193	11.4	217	6	14	10	1	0
Loam 20%	10	1220	14.9	402	6	14	8	1	0
Sawdust	12	1200	12.7	410	6	14	10	1	0

Table 12. Studies of Hard Surfacing Materials With Sandy Loam (Delta)

Soil Type	Cement	Weight	Mois- ture Gain	Crush- ing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
	%	Grams	%	Lbs.	Months	Number		Cores	
Sandy	6	1569	18.3	179	24	3	3	0	0
Loam 10%	8	1492	10.6	170	24	5	2	0	0
Rubber	10	1518	9.8	215	24	11	4	0	0
	12	1540	10.0	239	24	11	4	0	0
Sandy	6	1485	15.2	161	24	3	3	0	0
Loam 20%	8	1493	13.5	199	24	4	8	0	0
Rubber	10	1496	9.9	204	24	11	12	0	0
	12	1512	10.6	287	24	11	14	0	0
Sandy Loam	6	1536	13.6	486	24	6	9	0	0
10%	8	1552	11.6	460	24	20	9	0	0
Fiberglass	10	1607	11.6	670	24	14	13	0	0
	12	1571	11.6	539	24	14	13	0	0
Sandy	6	1495	11.8	532	24	11	9	0	0
Loam 20%	8	1574	9.8	505	24	19	12	0	0
Fiberglass	10	1614	8.1	777	24	20	12	0	0
	12	1641	11.8	640	24	20	12	0	0
Sandy	6	1578	13.2	318	24	1	1	0	0
Loam 5%	8	1550	11.4	228	24	12	2	0	0
Rubber	10	1686	6.6	545	24	12	4	0	0
	12	1713	4.4	383	24	13	13	0	0
Sandy	6	1622	17.3	1147	24	12	11	0	0
Loam 5%	8	1673	13.1	1673	24	18	12	0	0
Fiberglass	10	1646	13.3	1354	24	29	16	0	0
	12	1684	13.5	1960	24	29	16	0	0
Sandy	6	1644	10.4	427	18	3	0	0	0
Loam	8	1716	11.8	900	18	2	0	0	0
	10	1713	10.5	587	18	3	0	0	0
	12	1691	11.9	780	18	3	0	0	0
Sandy	6	1759	9.4	361	13	3	2	0	0
Loam	8	1775	7.4	557	13	8	9	0	0
5%	10	1698	7.1	541	13	13	13	0	0
Limestone	12	1746	7.2	756	13	22	15	0	0
Sandy	6	1714	12.1	361	13	3	2	0	0
Loam 10%	8	1746	9.2	518	13	3	2	0	0
Limestone	10	1687	7.5	581	13	13	12	0	0
	12	1793	7.1	924	13	13	15	0	0
Sandy	6	1742	10.5	510	13	3	2	0	0
Loam 20%	8	1769	7.8	621	13	9	9	0	0
Limestone	10	1841	6.3	892	13	13	15	0	0
	12	1794	5.1	995	13	25	16	0	0
Sandy	6	1446	14.0	233	6	5	4	0	0
Loam 5%	8	1428	14.0	250	6	5	4	0	0
Sawdust	10	1524	9.2	543	6	9	5	0	0
	12	1535	9.6	665	6	9	7	0	0
Sandy	6	1225	16.5	147	6	5	4	0	0
Loam 10%	8	1282	15.6	291	6	9	5	0	0
Sawdust	10	1366	14.6	486	6	11	5	0	0
	12	1348	11.2	514	6	11	10	0	0
Sandy	6	1047	25.2	215	6	9	4	0	0
Loam 20%	8	1022	21.7	273	6	9	3	0	0
Sawdust	10	1086	17.3	288	6	12	8	0	0
	12	1076	18.7	355	6	12	10	0	0

Table 13. Studies of Hard Surfacing Materials With Plastic Clays

Soil Type	Cement	Weight	Moisture Gain	Crushing PSI	Test Length	Cycles Completed		Still in Test	
						Wetting Drying	Freeze Thawing	Wetting Drying	Freeze Thawing
	%	Grams	%	Lbs.	Months	Number		Cores	
Susequehanna Subsoil	6	1612	14.5	474	18	1	0	0	0
	8	1602	9.6	426	18	1	0	0	0
	10	1658	16.8	548	18	1	0	0	0
	12	1667	6.6	894	18	8	0	0	0
Yazoo City Subsoil	6	1418	0		18	0	0	0	0
	8	1412	0		18	0	0	0	0
	10	1604	0		18	0	0	0	0
	12	1576	0		18	0	0	0	0
Sharkey Clay Subsoil	6	1416	0	216	18	0	0	0	0
	8	1401	0	222	18	0	0	0	0
	10	1406	19.8	194	18	1	0	0	0
	12	1410	0	230	18	0	0	0	0
Sharkey 5% Lime-stone	6	1517	0	322	13	0	0	0	0
	8	1577	9.2	311	13	1	1	0	0
	10	1653	7.8	396	13	1	1	0	0
	12	1589	9.6	376	13	1	1	0	0
Sharkey 10% Limestone	6	1482	0	341	13	0	0	0	0
	8	1492	0	285	13	0	0	0	0
	10	1569	16.9	368	13	1	1	0	0
	12	1491	20.6	307	13	1	1	0	0
Sharkey 20% Limestone	6	1556	0	325	13	0	0	0	0
	8	1608	13.8	336	13	1	1	0	0
	10	1587	12.9	395	13	1	1	0	0
	12	1585	13.4	443	13	1	1	0	0

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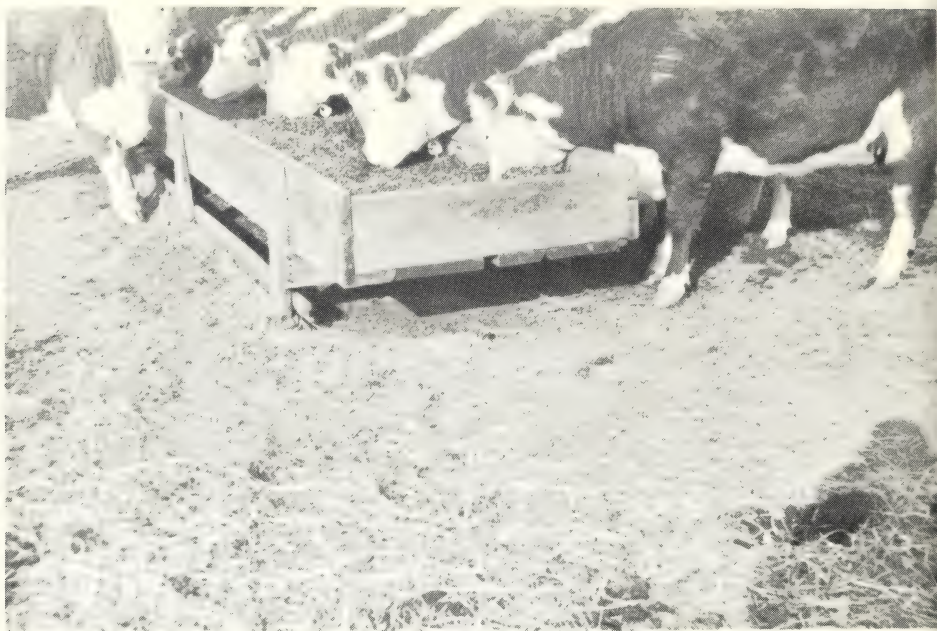
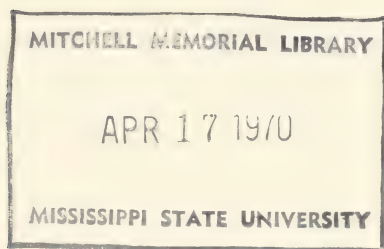


Figure VIII. Beef animals being fed on soil-cement hard surfacing at North Mississippi Branch Experiment Station, Holly Springs, Mississippi.

Mechanical Gleaning and Ginning Of Ground-Loss Cotton In The Yazoo-Mississippi Delta



Mississippi State University

AGRICULTURAL EXPERIMENT STATION

JAMES H. ANDERSON, Director

STATE COLLEGE

in cooperation with
Farm Production Economics Division
Economics Research Service
U. S. Department of Agriculture

MISSISSIPPI

PREFACE

The preparation of the manuscript for this publication was begun in 1964, but there has been considerable delay in processing the manuscript due to the death in November 1965 of the designated senior author.

With the interim drastic reduction in cotton acreage and in the practice of reclaiming cotton from the ground, the manuscript was set aside, but with the increase in cotton acreage in 1968 it is believed that the publication will fill a need.

Even though the study was conducted in the years 1961-1963 it represents the most recent and best available data on the subject of gleaning cotton from the ground in the Mid-South, and it is believed that the information should be made available to the cotton industry.

MECHANICAL GLEANING AND GINNING OF GROUND-LOSS COTTON IN THE YAZOO-MISSISSIPPI DELTA

By MORRIS M. LINDSEY, CHARLES S. SHAW, and JOE E. CLAYTON¹

Field or ground-loss of seed cotton has been a major source of complaint against mechanical harvesting since the advent of the mechanical cotton picker. Improved design in mechanical pickers and supporting machinery coupled with new production technologies and agronomic practices have lessened field loss, but ground losses are still excessive. Weather and field and plant conditions will affect the amount of ground-loss cotton, but the loss will usually range from 5 to 15 percent of the total crop.

Field or ground-loss cotton may be divided into two basic groups: (1) pre-harvest losses, and (2) those that occur during the harvesting operation. Preharvesting losses may occur normally when mature open boll varieties are allowed to remain in the field too long before they are harvested. Wind and rain may cause severe preharvesting ground loss in such mature cotton. The mechanical cottonpicker operating under ideal conditions will normally leave from 5 to 8 percent of the crop on the stalk and ground under the plant. If the cotton is very mature and the stalk and stems have become brittle, shattering will occur and the efficiency of the mechanical

picker will be lowered with a resulting increase in ground-loss cotton.

In the early years of mechanical harvesting, farmers looked on the waste associated with mechanical picking as an unavoidable loss. A few producers were mindful of the loss and attempted to salvage part of this waste by hand gleaning. This process was slow and expensive. As yields increased and the mechanical picker gained general acceptance, farmers became interested in the development of a mechanical gleaner to salvage the ever-increasing ground loss. Several of these mechanical gleaners have been developed and tested in the last 5 or 6 years.

Mechanical cotton gleaners were first used in the West where high yields and ideal weather conditions are conducive to ground retrieving. After successful operations in California and Arizona the practice spread eastward and the first known use of the mechanical gleaner in the Midsouth occurred in 1961, when approximately 15 machines gleaned about 350 bales of cotton from the ground.

Following their introduction, the number of machines and extent of use has increased in each area where the gleaners are used, table 1.

Arizona, where 11 percent of the 1964 crop was mechanically gleaned, led the Cotton Belt in percentage of the cotton crop mechanically retrieved and in the number of bales retrieved (80,960 bales). Texas, with only 1 percent of its cotton production mechanically gleaned, had 40,140 bales of ground-loss cotton salvaged in 1964. Slightly better than 1 percent of the 1964 total cotton crop was mechanically gleaned and this salvaged portion

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The authors express appreciation to E. B. Williamson for his cooperative assistance in this study.

Credit is due Fred T. Cooke, Jr. for contributions he has made in the economic portion of this publication.

Table 1. Field-loss cotton salvaged from the ground by mechanical gleaners, by selected States, ^{1/}
1964 harvesting season ^{2/}

State or area	Percent of total crop	Bales gleaned mechanically	Pounds seed cotton per bale
Arizona	11	80,960	2,405
California	3	53,580	2,640
Missouri	1	4,190	2,146
New Mexico	4	8,760	2,549
Texas	1	40,140	2,442

¹ Those States with less than 0.5 percent of their total cotton production harvested by mechanical gleaners are not presented in this table. The United States total is not presented because of possible rounding error and the exclusion of those State totals that did not amount to 0.5 percent of the State production.

² From the report "Charges for Ginning Cotton, Costs of Selected Services Incident to Marketing and Related Information, Season 1964-65," ERS-2 (1960), Washington, D.C. May 1965.

of the total production contributed over \$22 million to cotton producers.

Although less than 0.5 percent of the Mississippi Delta cotton crop was mechanically gleaned in 1964, it was estimated by machinery dealers, farmers, and agricultural personnel that some 150 gleaners, both owned and custom rented, were in operation in the area. These machines salvaged from 4,500 to 6,000 bales worth an estimated \$1/2 to \$3/4 million during the 1964 harvesting season.

Method of Study

The study of mechanical gleaners in the Delta of Mississippi was initiated in 1961 at the Delta Branch of the Mississippi Agricultural Experiment Station at Stoneville, Mississippi, by the Agricultural Engineering Research Division of the Agricultural Research Service, including the U. S. Cotton Ginning Research Laboratory of ARS, and the Farm Production Economics Division of the Economic Research Service.

The study was divided into three broad phases. Engineers studied the physical and operational limits of the mechanical gleaner. They also had to determine the average amount of ground-loss cotton left by mechanical harvesters and if weather conditions would permit operation of the gleaners for a sufficient length of time each season. Cotton technologists were responsible for the cotton ginning

research, and for determining qualities of the gleaned cotton. Techniques for handling and ginning the salvaged ground-loss cotton were developed and studied in order to receive the best possible price for this cotton. The third phase dealt with a complete economic analysis of a gleaner operation at the farm level to determine at what levels of use the gleaning operation would pay the farmer. The economic phase of the study also concerned itself with ginners and their problems and thoughts concerning the handling of ground-loss cotton.

Field Experiments and Analysis

The machine used in the first gleaning experiments at Stoneville in 1961 was a 2-row, skip-row, tractor-drawn harvester which utilized 14 notched or partly sliced rubber belts.² The belts rotate around a sheave which bends the belts in such a manner that the notches open on the bottom side of the belt as it rolls along in contact with the ground. The gleaning action of the belts occurs when the open notches in the belts close after having rotated around the sheave and in close contact with the ground grasp and pickup the cotton that is loose on the ground, figure 1. The belts are 2

²The mention or illustration of certain types of cotton gleaning machines as used in this study does not imply an endorsement over other commercial types not mentioned.



Figure 1 — Showing how cotton locks are grasped by the notched belt of the gleaning machine.

inches wide and are individually mounted side by side on a floating arm and sheave arrangement to allow them to follow the contour of the row middle.

The gleaned cotton travels in the notches along the lower edge of the belt and is passed to a smaller set of similar belts. Some dirt and trash picked up from belt contact with the ground is lost during this transfer of the retrieved cotton. The second set of belts delivers the cotton further back into the machine to a drag-chain conveyor that elevates the cotton into the storage hopper at the rear of the pickup unit.

Leaves, stems, and small trash are typical litter found in a row middle during the late picking season, particularly if the cotton has been defoliated. Figure 2 is a good illustration of a clean row middle after the notched-belt harvester has passed. It is readily apparent here that

most of the ground-loss cotton has been salvaged but it is equally apparent that most of the row trash has accompanied the cotton.

The storage hoppers for the retrieved cotton are hinged to dump from the bottom. Each hopper will hold approximately 200 pounds of retrieved cotton and row trash. The usual procedure is to dump the cotton at the end of a row so that the machine can continue operating while the cotton is loaded into the trailer as a separate operation, figure 3. Cotton may be loaded from the ground by hand with a fork or it may be elevated to the trailer by a portable fan as shown in figure 4. Loading with the portable fan is faster and easier and has an added advantage in that considerable dirt and leaf trash is discarded during the operation.

During initial tests at Stoneville in 1961, the notched-belt gleaner was operat-



Figure 2 — Showing clean middle after one pass with the notched-belt harvester early in the season.

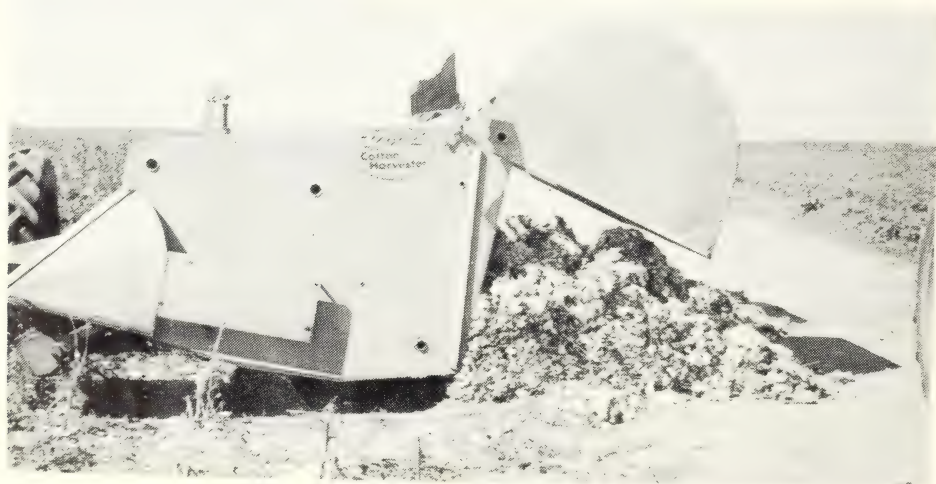


Figure 3. — Gleaned cotton is bottom-dumped from hoppers on rear of the machine. Each hopper will hold approximately 200 pounds of gleaned cotton.

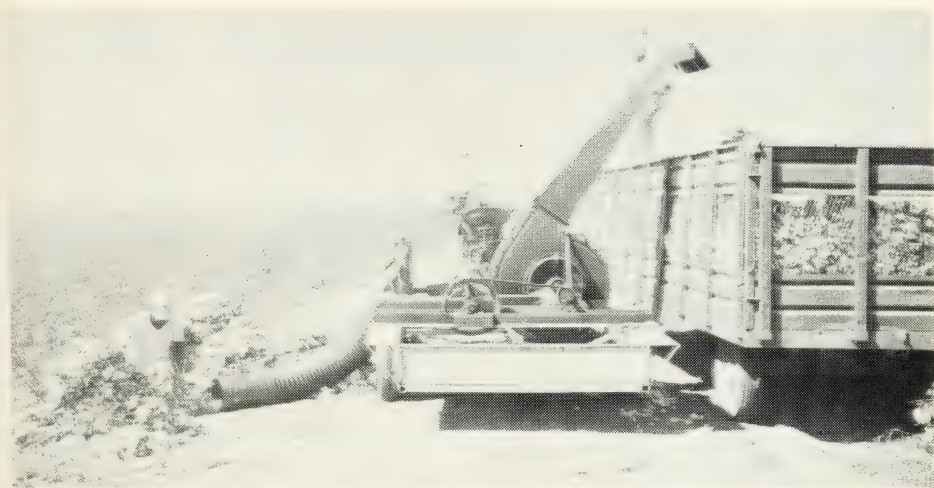


Figure 4. — The operator can discard some of the large trash when loading cotton with a portable fan.

ed as early as October 12, after the first picking, and as late as February 12, 1962, after the stalks were cut and shredded. The October 12, 1961, test started with the removal of the doors from a 2-row picker in order to scatter cotton from the stalk over the middle to test the gleaning efficiency and capacity of the notched-belt harvester. Much of the cotton was thrown against the stalks and this caused serious overloading of the outer belts of the gleaner during operation.

Despite this overloading condition of the outer belts, the gleaner picked up this cotton at the rate of 1 bale to the acre. Total trash content of the seed cotton averaged 35 percent and total lint foreign matter content, as determined by the Shirley Analyzer, was 3.04 percent. This particular cotton graded LM+, 1 1/16-inch staple with a 1961 market value of 33.5 cents per pound. This was comparatively early-season, white cotton and was not exposed to rains, and was processed through the following machinery at the gin: tower drier, 6-cylinder cleaner, bur machine with stick remover attachment, 13-cylinder cleaner, extractor-feeder

and double lint cleaning.

In rank cotton after first picking, the gleaner did some damage to the stalks and green bolls. Cotton retrieved from under the rank-growing plants often contained more than 50 percent trash due to fallen leaves after defoliation. Table 2 presents the variation in trash content of gleaned cotton in one area of a field where stalk height was from 2 to 3 feet and in another area of the same field where stalk height was from 5 to 7 feet. It is quite apparent that taller and ranker growing cotton is characterized by heavier concentration of leaf and stem trash in the row middle. The additional trash under the rank-growing stalks is reflected in the increased weight of the material picked up from plots number 5, 6, and 7. No pattern in gleaning time per acre was discernible between plots with the shorter stalks and those of the more rank-growing plants.

Frequent rains and wet fields prevented the operation of the notched-belt gleaner during the month of November 1961. In December gleaning tests were resumed following rains and two lots of cotton were recovered with an average

Table 2. Percent trash by type and total for seed cotton gleaned with notched belt gleaner, Stoneville, Miss., field No. 6, Oct. 25, 1961 ^{1/}

Item	Unit	Plot number						
		1	2	3	4	5 ^{2/}	6 ^{2/}	7 ^{2/}
Plant height	Feet	2-3	2-3	2-3	2-3	5-7	5-7	5-7
Hulls	Percent	6.4	5.8	13.8	10.5	—	—	—
Sticks and stems	Percent	2.9	4.7	4.3	6.5	—	—	—
Leaf	Percent	5.4	2.6	4.8	4.7	—	—	—
Grass	Percent	4.0	5.2	2.0	3.0	—	—	—
Miscellaneous trash								
Large	Percent	4.6	5.5	5.6	6.1	4.1	2.4	2.4
Small	Percent	2.5	2.9	2.6	2.4	3.4	2.7	2.2
Total trash	Percent	25.8	26.7	33.1	33.2	61.5	70.3	76.2

^{1/} Average of three replications. Yield of seed cotton was approximately 1 bale per acre and seed cotton gleaned ranged from 45 to 270 pounds per acre.

^{2/} Complete breakdown of trash in plots 5, 6, and 7 was not obtained because of the high percentage of leaf trash.

Table 3. Percentage of trash content for seed cotton retrieved from ground, using the notched-belt type mechanical gleaner, Stoneville, Miss., Dec. 2, 1961 ^{1/}

Item	Wagon sample			Feeder sample		
	Lot 1	Lot 2	Average	Lot 1	Lot 2	Average
	Percent					
Hulls	13.0	10.4	11.7	1.9	2.5	2.2
Sticks and stems	8.9	10.4	9.6	5.8	6.9	6.4
Grass	3.3	5.0	4.2	1.7	1.9	1.8
Large leaf	2.9	2.0	2.4	.3	.5	.4
Small leaf	2.0	1.5	1.8	.7	1.5	1.1
Pin trash	8.0	6.8	7.4	1.5	1.1	1.3
Motes	.7	.7	.7	.3	.4	.4
Total trash	38.8	36.8	37.8	12.2	14.8	13.5

^{1/} The figures are an average of nine samples from each lot.

Table 4. Gleaning efficiency of the notched-belt type mechanical gleaner in six varieties of cotton, Stoneville, Miss., December 1961

Variety	Seed cotton per test plot ^{1/}				Gleaner efficiency	
	Machine picked	Hand ^{2/} gleaned	Machine gleaned ^{2/}		1st trip	2nd trip ^{3/}
			1st trip	2nd trip		
	Pounds	Pounds	Pounds	Pounds	Percent	Percent
Lankart 57	53.8	13.6	7.9	—	58.0	—
Acala 4-42	86.6	26.6	8.4	5.9	31.6	53.8
Northern Star 4-11	81.5	25.9	6.5	4.9	25.1	44.0
D&PL Smooth Leaf	84.1	24.5	8.8	6.4	35.9	62.0
Delfos 9169	62.2	15.7	6.4	4.6	40.8	70.1
Stoneville 7	68.8	10.2	8.0	—	78.4	—

^{1/} Test plots measured 0.025 acres.

^{2/} Included trash.

^{3/} Total efficiency (sum of two trips).

trash content of 37.9 percent (table 3). Two different gin machinery arrangements were used to process these two lots of cotton as follows:

Lot No. 1 tower drier 6-cylinder cleaner, bur machine with stick remover attachment, tower drier, 7-cylinder cleaner, extractor-feeder and double lint cleaning.

Lot No. 2 same as Lot No. 1, except six additional cylinders of cleaning following the bur machine.

Both wagon samples and feeder samples were fractionated and the trash breakdown is presented in table 3. Total lint foreign matter content, as measured by the Shirley Analyzer, averaged 4.37 percent. The first lot of this cotton graded "GO" with a 1-inch staple length and was worth 30.5 cents per pound in 1961. The second lot of cotton was classed 'Below Grade' with a 31/32-inch staple

that was worth 29 cents per pound. These 1961 prices were obtained from the Staple Cotton Cooperative Association at Greenwood, Mississippi.

To measure the 'gleaning efficiency' of the notched-belt type mechanical gleaner, several row middles were carefully gleaned by hand following mechanical harvesting. Using this amount of gleaned cotton as a base, the notched-belt mechanical gleaner was operated in adjacent row middles and the cotton retrieved was expressed as a percentage of that gleaned by hand (table 4). These efficiency tests were conducted on six varieties of cotton during December 1961. The efficiencies ranged from a low of 44 percent in the Northern Star 4-11 variety after two passes with the mechanical gleaner to 78.4 in the Stoneville 7 variety where only one pass was made.

Gleaning conditions were not ideal in

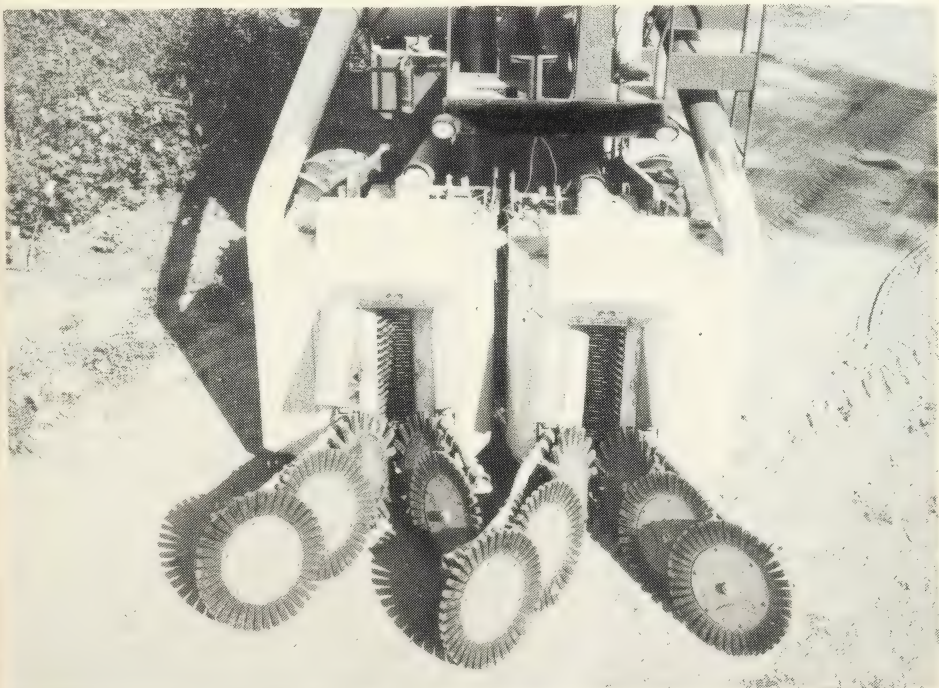


Figure 5. — Showing cotton pickup wheels mounted on front of a spindle picker on hinged arms. The individual wheels rise to follow contour of the ground.

December due to wet grounds. It was difficult for the tractor to pull the machine through soft areas in the field, and mud often clogged the notches or slots in the rotating belts. A percentage of the cotton that would normally have been retrieved was pressed into the muddy ground by the passage of the tractor tires.

In 1963 another type of mechanical gleaning unit was used in experiments at Stoneville. This unit differs from the notched-belt type gleaner in that it is not tractor-drawn but mounts on the front of the mechanical harvester. Mounted on the front of a conventional spindle picker, the unit gleans cotton from the ground concurrent with the final machine

scrapping operation; thereby saving an additional pass through the field with another power unit. However, the unit can be operated solely as a gleaner after final scrapping.

The 'cotton pickup wheels' type gleaner is shown in figure 5 mounted on the front of a conventional 2-row spindle-type mechanical harvester. The unit consists of two hinged arms extending in a V-shape in front of the picker head. A series of wheels with rubber fingers around the periphery are individually mounted along the hinged arms so they can follow the contour of the ground. The rubber-fingered wheels are ground-driven and rotate as they maintain contact with the ground. The V-shape of the hinged

Table 5. Classification, market value, moisture and foreign matter content of seed cotton harvested by various methods, Stoneville, Miss. October 1963 ^{1/}

Test item	Machine scrapping	Machine scrapping plus ground gleaning ^{2/}	Ground gleaning ^{2/}
Grade, index	100.0	94.0	^{3/} 85.0
Staple length, 32nd inch	34.0	33.7	33.0
Market loan value, cents per pound	34.04	32.34	30.14
Moisture content, percent			
Wagon sample	9.8	9.4	7.8
Feeder sample	6.4	6.8	5.9
Lint sample	3.5	3.3	3.3
Lint, foreign matter content, percent	9.93	2.35	3.35
Seed cotton, foreign matter content, percent			
Wagon sample:			
Hulls	3.9	2.8	3.8
Sticks and stems	1.7	2.3	6.0
Grass	0	1.0	.1
Large leaf	1.0	.5	.5
Small leaf	1.9	3.7	7.2
Total leaf	2.9	4.2	7.7
Motes and fly ^{4/}	3.1	5.0	8.5
Total foreign matter	11.6	15.3	26.1
Feeder sample:			
Hulls	1.0	.6	1.2
Sticks and stems	.4	.5	.9
Grass	.0	.1	.1
Large leaf	.1	.1	0
Small leaf	.2	.3	.4
Total leaf	.3	.4	.4
Motes and fly ^{4/}	1.0	1.0	3.3
Total foreign matter	2.7	2.6	5.9

^{1/} Figures are averages of three samples. ^{2/} Using rubber-fingered pickup wheels to glean. ^{3/} Two of three samples reduced one grade for rough preparation. ^{4/} Principally motes and fly but includes small amounts of other trash.

Table 6. Classification, market value, moisture and foreign matter content of seed cotton gleaned with rubber-fingered pickup wheels following heavy rains, Stoneville, Miss. Nov. 14, 1963 ^{1/}

Test item	Gleaned cotton
Classification:	
Grade, index	^{2/} 85.0
Staple, 32nd inch	32.0
Market loan value per pound, cents	28.64
Moisture content; percent	
Wagon sample	11.1
Feeder sample	10.2
Lint sample	4.9
Foreign matter content; percent	4.82
Wagon sample:	
Hulls	5.7
Sticks and stems	5.0
Grass	.9
Large leaf	2.4
Small leaf	5.4
Total leaf	7.8
Pin trash	1.0
Motes	.6
Total foreign matter	21.0
Feeder sample:	
Hulls	2.3
Sticks and stems	3.2
Grass	.6
Large leaf	1.5
Small leaf	2.1
Total leaf	3.6
Pin trash	.2
Motes	.6
Total foreign matter	10.5

^{1/} Figures are average of six samples taken from 1 bale.^{2/} Value of 81 = to SGO +.

mounting arms allows the outer set of wheels to move cotton from the row middle toward the row where the next set of rubber-fingered wheels moves the cotton progressively closer to the stalks until the final set of wheels lifts the retrieved cotton up onto the stalks where it is then picked by the spindles in the conventional manner. The gleaning action of the rubber pickup wheels is similar to the action of a side-delivery hay rake.

During October 1963, test plots of cotton at Stoneville were harvested by three different methods under identical field conditions. The three methods were as follows:

1. Conventional machine - scrapping from the stalk with a spindle-type mechanical harvester.

2. Machine - scrapping plus ground gleaning with rubber-fingered pickup wheels mounted on the front of a spindle-type picker.

3. Ground gleaning, as a separate operation, with rubber fingered pickup wheels after conventional machine-scrapping by spindle-type picker.

The cotton scrapped by harvesting method 1 gave a yield of 0.21 bales per acre with a ginning turnout of 33.2 percent. The cotton harvested by machine-scrapping plus ground gleaning gave a yield of 0.28 bales per acre with a ginning turnout of 31.2 percent. In method 3 where gleaning was a separate operation, the cotton was retrieved at the rate of 0.09 bales per acre and the gin turnout dropped to 26.0 percent. Table 5

shows the classification, market value, moisture and foreign matter content of the cotton based on the harvesting methods and treatments outlined above. The following gin machinery arrangement was used in processing this cotton: multi-path drier, 6-cylinder cleaner, bur machine with stick remover attachment, 7-cylinder cleaner, 13 cylinder cleaner, extractor-feeder, and double lint cleaning. These experiments were made in early October before any of the heavy fall rains had occurred and the high classification placed on this cotton indicates that gleaning and picking conditions were almost ideal.

On November 14, 1963, after a series of heavy rains had fallen on the ground-loss cotton, a bale of cotton was gleaned

from the ground with the rubber-fingered pickup wheels. The average grade index on six samples taken from this bale was 80.5 (SGO+) with an average wagon sample trash content of 21 percent. The 1963 market loan value for this bale of cotton was 28.64 cents per pound. The classification, market value, moisture and foreign matter content pertaining to this bale of recovered cotton is presented in table 6. The test values on this cotton indicate that the heavy rains materially affected the value of the cotton gleaned and indicated considerable deterioration in grade over the cotton gleaned in October.

The rubber-fingered pickup wheels gleaning attachment added considerable trash to the retrieved cotton and caused

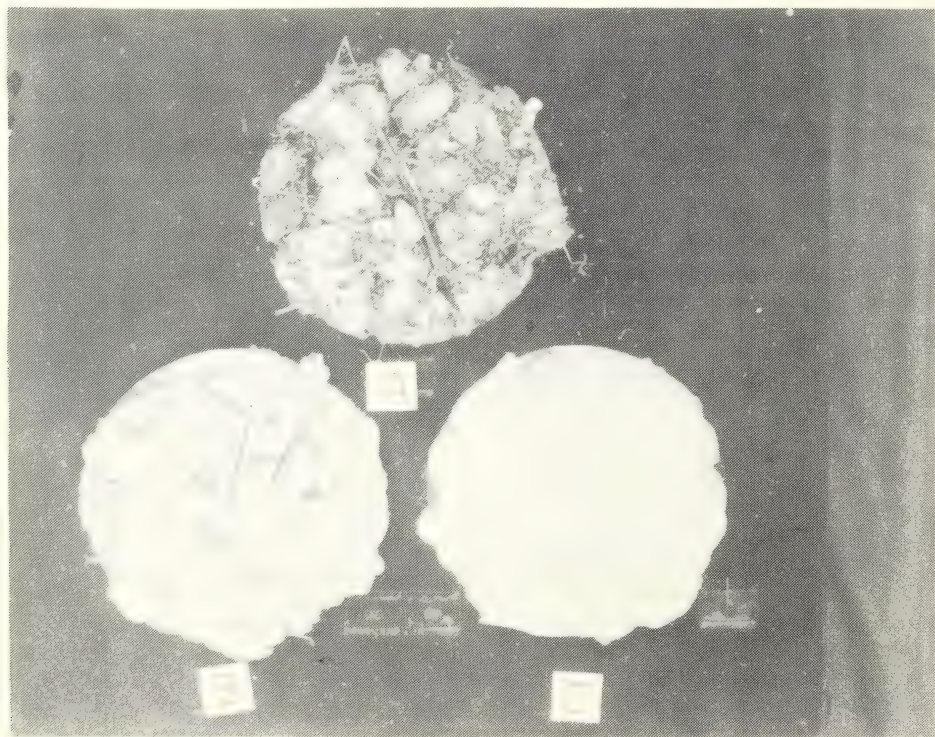


Figure 6. — Cotton gleaned from the ground in October: A, field sample; B, feeder sample after tower drier 225° F., 6-cylinder cleaner, bur machine with stick remover attachment, 13-cylinder cleaner and feeder-cleaner; C, ginned lint after processing as above plus double lint cleaning. The sample classed LM+, 1-1/16-inch staple.

additional wear to picker spindles and other moving parts of the mechanical picker. Dried leaves picked up by the attachment were broken into small bits by the action of the spindles, doffers, and air conveying system and became scattered throughout the cotton. In many instances where the soil was loose and soft, particles and clods of soil were carried into the mechanical picker and blown into the retrieved cotton causing some discoloration of the lint. Mechanical cottonpicker efficiency of the gleaning attachment and conventional picker operating concurrently was 91.8 percent as compared to 88.3 percent picker efficiency where the conventional picker was used without the gleaning attachment.

Approximately two-tenths of a bale was gleaned per acre from the ground with the rubber-fingered pickup wheels.

Ginning Experiments, and Fiber and Spinning Test Results

In general, a gin machinery setup normally recommended for machine-picked seed cotton could handle the ground-gleaned cotton. Basically, salvaged cotton should be subjected to adequate drying, 12 to 18 cylinders of cleaning, suitable extracting machinery, such as a stick and greenleaf machine, feeder-cleaners, and double lint cleaning. In some instances it was necessary to pass gleaned cotton through the overhead cleaning machinery twice before ginning was attempted. Some ginners prefer to

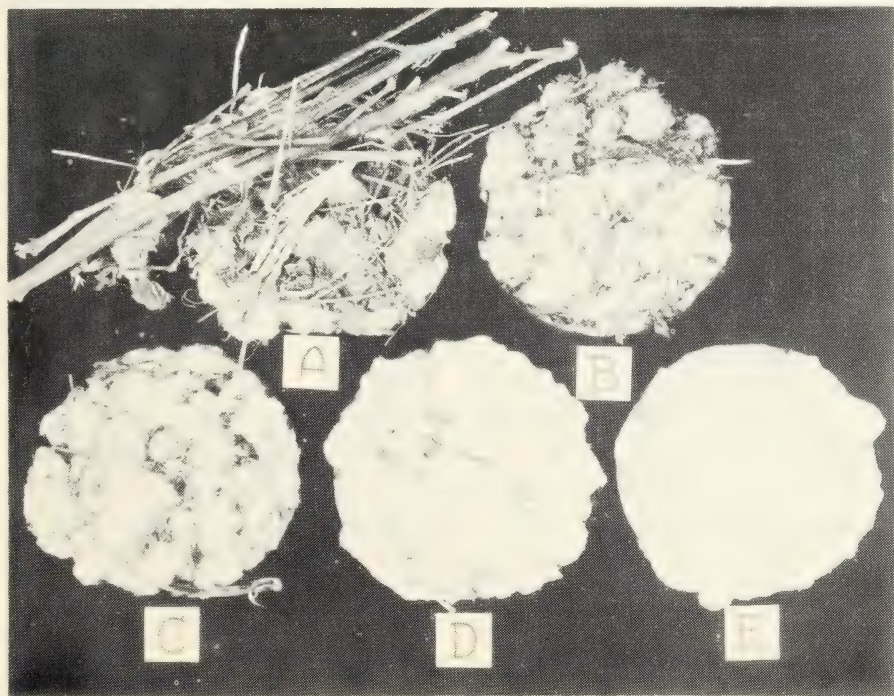


Figure 7. — A, sample of seed cotton as picked up with a notched-belt gleaner after pulling harrow over stalks; B, after large pieces of stalk and foreign matter removed by hand; C, sample of cotton after one pass through drier and overhead cleaning machinery at gin; D, sample after being passed twice through overhead cleaning plus extractor feeder; and E, resulting ginned lint after double lint cleaning.

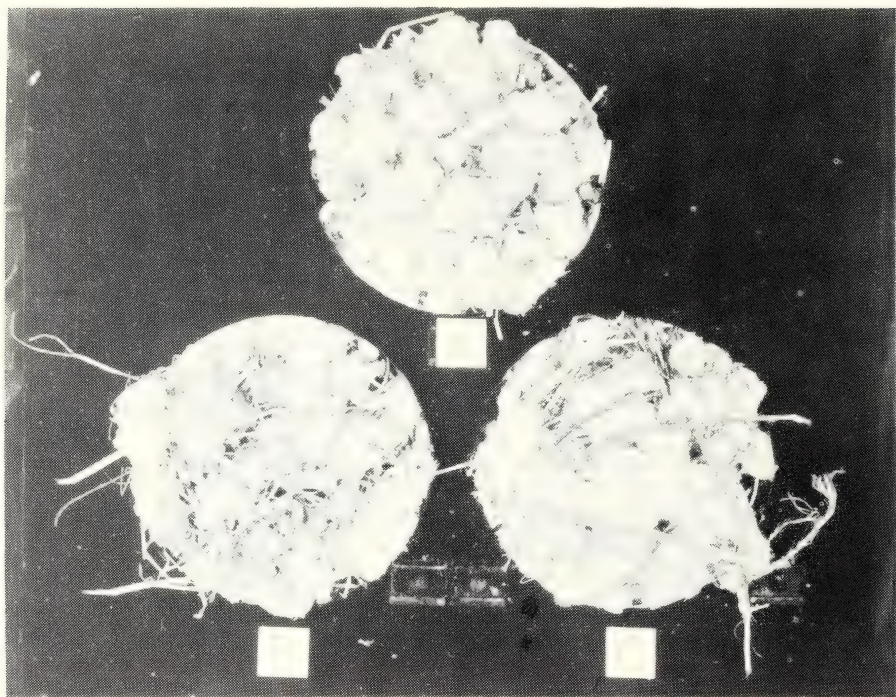


Figure 8. — Cotton gleaned from the ground: A, behind spindle picking; B, after pulling a spike-tooth harrow over stalks; and C, after cutting stalks with a rotary shredder.

pass the gleaned cotton through special cleaners and into storage until the end of the regular ginning season, to permit more time for special handling and ginning.

Figure 6 shows a sample of gleaned cotton from the initial tests at Stoneville in October 1961. This cotton was dry and fluffy and had received no rainfall after falling to the ground. Despite a heavy trash content of 35 percent, the lint graded LM+, 1/16-inch staple and sold for 33.5 cents per pound.

The ginning process for the cotton gleaned in the December 1961 tests is given in the legend under figure 6. This cotton was gleaned after a series of heavy rains and total trash content reached 37.9 percent. The lint from this

lot of gleaned cotton graded SGO with a 1-inch staple and was valued at 30.5 cents per pound.

A gleaning operation was observed and samples of the gleaned cotton obtained on a farm near Stoneville in 1962, after a spike-toothed harrow had been pulled over the field to shatter cotton from the stalks. This practice increased the size and quantity of stalk trash in the ground-gleaned cotton and required removal of this larger trash by hand before the cotton could be safely passed through the cleaning machinery at a commercial gin. Figure 7 depicts a sample of seed cotton from this gleaning operation and during different stages of the ginning process. Despite an initial trash content of well over 50 percent, the end result

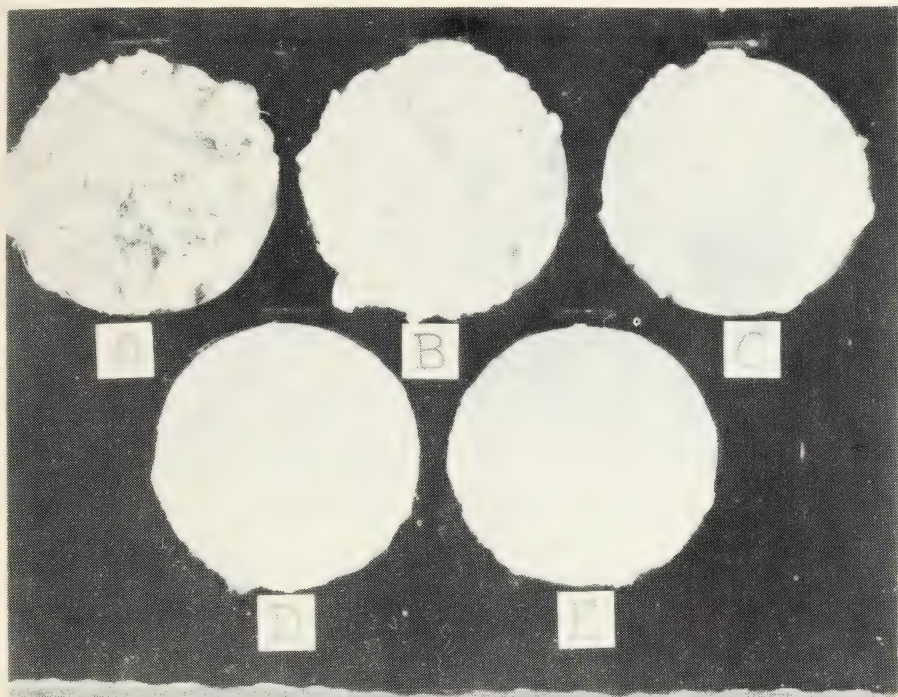


Figure 9. — Cotton machine-scrapped concurrently while gleaning by rubber-fingered wheels mounted on the front of the picker. A, wagon sample; B, feeder sample after 6-cylinder cleaner, bur machine with stick remover attachment, 7-cylinder cleaner, and extractor-feeder; C, feeder sample after 6-cylinder cleaner, bur machine with stick remover attachment, 7-cylinder cleaner, 13-cylinder cleaner, and extractor-feeder; D, lint after overhead cleaning in B, plus double lint cleaning classed SLM+, 1-1/6-inch lint; E, lint after overhead cleaning in C, plus double lint cleaning, classed SLM, 1-1/16-inch.

of the ginning process found a ready market. In figure 8 seed cotton gleaned under various ground conditions are shown. It is doubtful that cotton gleaned under conditions B and C (following a harrow or shredder) would prove profitable to either the farmer or ginner. In all instances, the cotton pictured in figures 6-8 was gleaned with the notched-belt type gleaner.

Some of the cotton gleaned during the October 1963 gleaning experiments with the picker mounted, rubber-fingered pickup wheels was subjected to the following two ginning arrangements:

1. Multi-path drier, 6 - cylinder cleaner, bur machine with stick remover attach-

ment, 7-cylinder cleaner, extractor feeder, and double lint cleaning.

2. Same as the above method except for the addition of a 13-cylinder cleaner.

Figures 9 and 10 show samples of cotton, harvested by two of the methods described in the previous section on gleaning tests during October 1963 using the rubber - fingered pickup wheels, at various stages in the ginning process. The more elaborate overhead cleaning (gin setup Number 2) produced a higher grade value in processing the machine-scrapped cotton, but failed to offer any advantage from a composite grade standpoint for the ground - gleaned cotton.

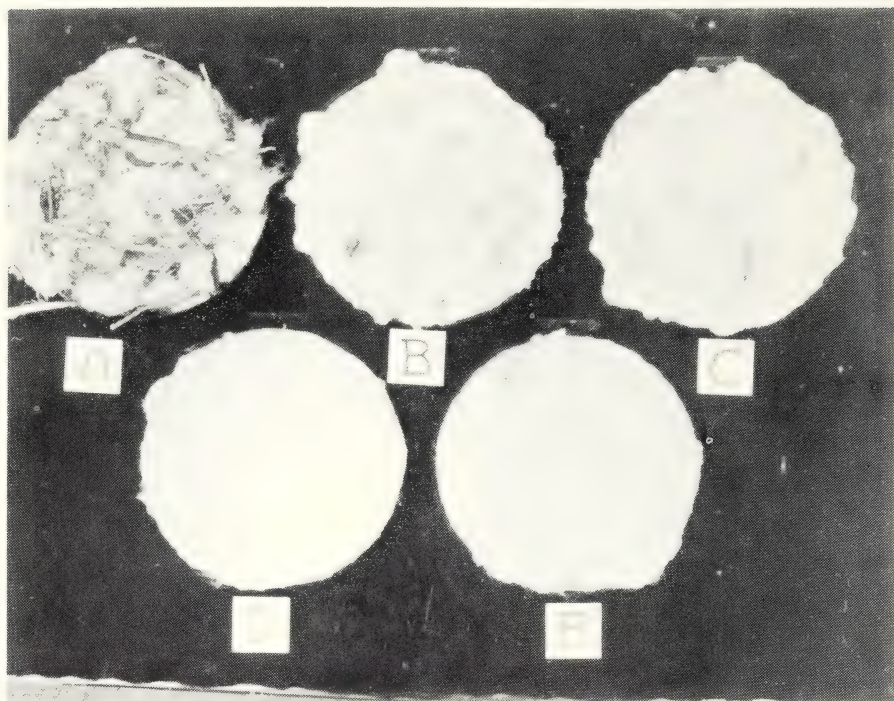


Figure 10. — Cotton gleaned from the ground using rubber-fingered wheels mounted on the front of a picker after final second picking. A, wagon sample; B, feeder sample after 6-cylinder cleaner, bur machine with stock remover attachment, 7-cylinder cleaner, and extractor-feeder; C, feeder sample after 6-cylinder cleaner, bur machine with stick remover attachment, 7-cylinder cleaner, 13-cylinder cleaner, and extractor-feeder; D, lint after overhead cleaning in B, plus double lint cleaning classed LM+, 1-1/16-inch; E, lint after overhead cleaning in C, plus double lint cleaning, classed LM, 1-1/32-inch.

Actually, the processing of the ground-gleaned cotton through the more elaborate overhead cleaning system resulted in a grade loss due to rough preparation. The 1963 market loan prices for these various samples ranged from 30 to 34 cents per pound.

Some cotton was gleaned with the rubber-fingered pickup wheels attachment after heavy fall rains had fallen on the ground - loss cotton and the resulting ginned lint classed SGO+ with a 1-inch staple.

Fiber and spinning tests were performed on the lint obtained from ginning the October and November gleaning tests in

1963 using the picker-mounted rubber-fingered pickup wheels. Six 1/2 - bale lots were sent to the Texas Tech Pilot Spinning Plant at Lubbock, Texas, for complete fiber and spinning analysis. Table 7 is a summarization of these data. The fibrograph mean and upper half mean fiber length measurements were slightly lower for the ground-gleaned cotton than for the machine scrapped plus ground-gleaned cotton. All of the fibrograph uniformity ratio figures, however, fell within the average range. A higher percentage of fibers shorter than one-half inch were associated with the ground-gleaned cotton. Picker and card

Table 7. Fiber and spinning test results for seed cotton by method of harvest, Stoneville, Miss., October 1961.

Test item	Machine scrapped		Harvesting treatment Machine scrapped + ground gleaned		Ground gleaned ¹	
	Gin 1	Gin 2	Gin 1	Gin 2	Gin 1	Gin 2
Fibrograph data:						
Upper half mean length, inches	1.07	1.06	1.07	1.04	1.04	1.03
Mean length, inches	.85	.83	.85	.83	.81	.81
Uniformity ratio	79	78	79	80	78	79
Raw stock nep count per 100 square inches of web	42	42	39	45	53	82
Fiber data:						
Strength index ("O" gauge), 1,000 psi	82.5	84.0	80.7	82.3	80.1	79.3
Micronaire, reading	3.9	3.9	3.7	3.6	3.1	3.1
Fibers shorter than ½ inch, percent ²	13.8	13.2	12.8	16.2	20.0	18.8
Spinning data:						
Picker and card loss, percent	6.81	6.73	7.55	8.00	9.62	9.14
Neps, per 100 sq. inches of card web	39	29	31	32	61	51
Ends down (corrected) MSH	36	35	25	42	116	84
Yarn break factor (corrected)	2,130	2,126	2,082	2,037	1,758	1,733
Yarn grade (30's), designation	B	B-	C	C	C-	C

¹ Using rubber-fingered pickup wheels mounted to front of conventional spindle-type mechanical picker.

² As determined by fiber arrays.

waste, both raw stock and card web nep counts, and ends down were higher for the ground-gleaned cotton. Yarn grade was also lower for the ground-gleaned cotton. However, these measurements are normal expectancy for dirty, trashy cotton. Despite these restrictions, the gleaned cotton had certain usable properties and qualified in grade for market loan.

Miniature spinning tests were performed on samples of the ginned lint from the cotton gleaned in November 1963 after heavy rains. The picker-mounted rubber-fingered pickup wheels were used to glean this cotton. The results of these spinning tests are summarized in table 8. The tests indicated a very low fiber uniformity index, a very high raw stock nep count of 86, and a rather high short fiber content of 19.9 percent.

Economics of Cotton Gleaning

The economic factors associated with cotton gleaning were studied under farm conditions in 1962 and 1963. In 1962 field studies of cotton gleaning were made on 16 Mississippi Delta farms. The acreage gleaned on these farms ranged from 48 to 352 acres. In 1963 field studies were conducted on 23 farms which gleaned from 72 to 698 acres of cotton.

Gleaning was done either by the farmer who owns his own gleaning equipment or by a custom operator who received one-half of the receipts from the sale of the gleaned cotton. Table 9 presents the yields, grades, costs, and returns associated with gleaning one bale of cotton if the producer owned his own machine. The costs associated with oper-

ating the gleaner are based on gleaning 200 acres of cotton a year for 10 years and a \$6,000 investment in gleaning equipment.

As indicated in table 9, the average returns above specified costs to a farmer who owns his own gleaning equipment

was \$61.18 per bale in 1962 and \$87.07 in 1963. The difference in returns is due to a greater amount of cotton being in the field in 1963. The amount of cotton to be gleaned in any given year will be determined by production and weather at harvest time. The higher the yield pro-

Table 8. Fiber and spinning data based on miniature spinning tests for ground-gleaned cotton following rains, Stoneville, Miss., Nov. 14, 1963¹

Test item	Ground-gleaned Cotton ²
Fibrograph data:	
Span length:	
66.7 percent, inches	.31
50.0 percent, inches	.41
2.5 percent, inches	1.05
Uniformity, index	39
Fibers shorter than one-half inch, percent ³	19.9
Yarn: Skein strength, pounds	83
Coefficient of variation, percent	6
Raw stock nep count, 100 sq. inches of web	86

¹ Figures are averages of three samples.

² Cotton gleaned with rubber-fingered pickup wheels front mounted on conventional spindle-type mechanical picker.

³ As determined by fiber arrays.

Table 9. Average per bale data pertaining to cotton gleaning costs in the Mississippi Delta when the machine belongs to the producer, crops of 1962 and 1963

Item studied	Crop year ¹	
	1962	1963
Cotton recovered per acre, pounds lint	62	83
Seed cotton recovered per acre, pounds	276	374
Acres required	8	6
Seed cotton recovered per hour, pounds	367	497
Seed cotton required per 500-pound bale	2,312	2,246
Hours required to recover one bale	6	4.5
Gleaning costs, dollars ²	59.64	44.73
Ginning costs, dollars	34.78	28.90
Grade and staple length of lint, designation	BG 1-1/32	GO 1-1/32
Market price of lint per pound, cents	25.80	³ 26.64
Market price, dollars	129.00	133.20
Net return to producer, per bale of lint, dollars	69.36	88.47
Ginning costs above seed value, dollars	8.18	1.40
Net returns to producer, dollars ⁴	61.18	87.07

¹ In 1962 the study involved 16 producers with gleaning acreage ranging from 48 to 352, and in 1963, 23 producers with gleaning acreage ranging from 72 to 698. (These are owner figures only. No custom or contract operator acreage is included here.) 1962 was about a normal harvest season in the Mississippi Delta area, so far as weather is concerned, while 1963 was extremely dry and good through the middle of November.

² Including costs of labor, repairs, and investment in machinery pro-rated over a period of 10 years.

³ Based on 1963 CCC Loan values at Greenwood, Miss.

⁴ To arrive at present-day figures, the same table format may be followed with calculations made on the basis of current cotton prices, and ginning and gleaning costs.

duced, the greater the amount of cotton that will be in the field for gleaning as was the case in 1963.

It should be pointed out that the loan price for good ordinary and below grade 1-1/32 cotton was very favorable in 1962 and 1963. The price was only 14 cents for good ordinary 1-1/32 - inch cotton in 1968 and 12.4 cents for below grade 1-1/32 - inch cotton. If these lower prices are used, the returns to the producer would only be \$2.18 in 1962 and \$15.87 in 1963.

Another critical factor to consider regarding a farmer - owned gleaner is whether the weather will permit the machine to be operated sufficiently to pay for the machine in most years. Data indicates that on the average only 3 days of fieldwork³ will be possible in November and December, the months when gleaning is usually done. This would result in higher costs than those shown in table 9 for gleaning as only

140 to 150 acres could be covered in 3 days.

Because of the limitations on the number of days which the gleaner could be used, it would be well for a farmer to consider the use of custom gleaning rather than owning his own machine. Table 10 presents yields, grades, costs, and returns associated with a custom gleaning operation in 1963. In this study 197 bales of cotton were gleaned from 1,182 acres. Custom gleaning is usually done on a share basis with one-half the proceeds from the sale of the cotton and cottonseed going to the producer. The farmer and the custom operator custo-

³Bolton, Bill; Penn, J. B.; Cooker, Jr., Fred T.; and Heagler, Arthur M., "Days Suitable for Fieldwork, Mississippi River Delta Cotton Area", Louisiana State University, D.A.E. Research Report No. 384, November 1968, table 4, page. 8.

Table 10. Average per bale data and final total net return to producer pertaining to gleaning cotton on an equal-share basis on 1,182 acres of a large farm in the Mississippi Delta, crop of 1963¹

Item studied	Crop of 1963
Cotton recovered per acre, pounds of lint	79.7
Seed cotton recovered per acre, pounds	390
Acres required	6
Seed cotton required per 500-pound bale, pounds	2,340
Seed cotton recovered per hour, pounds	519
Operating costs of gleaning machine to contractor per bale, dollars	24.75
Hours required to recover one bale	4.5
Ginning costs, dollars	26.30
Value of seed above ginning costs, dollars	1.20
Grade and staple length of lint, designation	GO 1-1/32
Market price of lint per pound, cents	26.64
Market price of cotton, dollars	133.20
Net return to producer per bale of lint, dollars	66.60
Net return on seed to producer (½ share) above ginning costs, dollars	0.60
Total net return to producer, dollars	67.20
Net return to gleaning machine contractor, dollars	42.45
Total net return to producer for 197 bales gleaned from 1,182 acres, dollars	13,238.40

¹ Gleaning was done on a farm where yield averaged more than two bales of cotton per acre. Some of this gleaned cotton was passed through a separator-cleaner before and at end of storage and was ginned at the conclusion of the regular ginning season when the gin could be operated at a slow rate of feed.

² Including labor, repairs, and investment in machinery.

³ Based on 1963 CCC Loan values, Greenwood, Miss.

⁴ To arrive at present-day figures the same table format may be followed with calculations made on the basis of current cotton prices, and ginning and gleaning costs.

marily share the ginning costs. The price received for good ordinary 1-1/32-inch cotton in 1963 was 26.13 cents per pound of lint. In 1968 the loan price for this cotton was only 14 cents per pound of lint. In 1968 the producers return from a bale of cotton would have been only \$35 plus 60 cents for the seed value after his share of the ginning costs had been deducted. The return to the custom operator with 1968 prices for this cotton would have only been \$10.25 per bale. Again the price of gleaned cotton has great impact on returns from gleaning.

Conclusions

It would appear that most farmers would be wiser to depend on custom operators for their gleaning rather than owning their own machine because of weather hazards and the possibility of low prices for gleaned cotton. Any return the farmer receives from custom glean-

ing would add to his net farm income at little or no risk. The only objection a farmer might have to gleaning would be that gleaning would delay the opportunity for doing fieldwork in the fall and early winter. In most cases, however, this would not be a serious objection on sandy soils as little tillage work is done on such soils during this time of the year.

The necessity for field and ground gleaning might eventually be eliminated by the further development of better mechanical picking varieties of cotton and by further improvement in the efficiency of mechanical pickers and improvement of cultural practices. Until such time as these developments come to pass, it now appears that the gleaning problem will still be present for some time and with it the questions as to whether or not gleaning will pay and how to do it better and cheaper.

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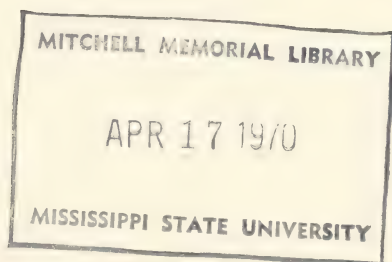
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Costs and Returns from Beef Cattle in the Brown Loam Area of Mississippi

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PREFACE

This publication reports the results of a survey of cattle producers in the Brown Loam area. Findings are reported in terms of averages and are based on estimates made by producers for a year's operation of their beef enterprises. The sample was not in an exacting sense random. Interpretation of the findings should be in light of what the data represent.

Records for one year often do not very well portray the story for an enterprise such as beef cattle. Inventories and prices both changed, giving a distorted view of costs and returns. In order to offset such factors, the data were reported so that

the effect of such changes can be seen.

Handling of charges for land and labor created problems. Including land charges at land prices reported by producers seemed unrealistic because, in many instances, the land had little or no alternative use. Therefore, land charges were not included except for silage and temporary grazing. Readers may adjust the costs and returns reported in the publication to fit their own situation of land values. The labor costs were handled in a manner which allows for adjustments in costs and returns for those using labor with various levels of alternative uses.

SUMMARY

The purpose of the research reported in this publication was (1) to estimate the costs and returns from cow-calf operations of different sizes and (2) to estimate the costs and returns from holding calves past weaning weight for a sample of farms in the Brown Loam Area of Mississippi.

Farms were classified according to size by the average number of brood cows on hand. A small herd consisted of from 30 to 50 brood cows; medium, from 51 to 100; and large, more than 100. Basic cost and return data were collected from 215 cow-calf producers in the Brown Loam Area of Mississippi for the year ending June 30, 1967.

It was found that only the large producers had a positive return over total cost, excluding land charges for permanent pasture and woodland grazing. There were apparently no economies associated with size in moving from a small to a medium sized herd, but definite economies in the large operations. Total costs per calf were \$140 for small herds, \$143 for medium herds, but only \$107 for large herds. In each case the major portion of the cost was for providing feed for the animals both by hand feeding and grazing.

There was very little difference in the prices received at the market. Therefore, producers having the lowest cost had the greatest returns above total cost. Of the three size groups only the producers with large herds netted a positive return over total cost: \$7.95 per calf on hand, excluding land charges. Producers with small and medium herds lost \$18.48 and \$16.90 per calf, respectively. When only operating costs were considered, there was a positive return for all groups. Owners of small herds netted \$15.98 above operating cost per calf on hand; medium herd owners, \$13.26; and those with large herds, \$35.10.

For some operators, the beef herd may not necessitate additional hired labor. For these, operating costs would not include a

charge for labor associated directly with the herd. For such operators, their returns above operating costs would be \$42.00, \$33.40, or \$49.51 per head. Further, some operators may be using resources that have been fully paid for. For this group returns per head would be somewhat higher, since, to them, neither the charge for interest or depreciation is a meaningful cost item.

A study of holding operations in which producers held calves past weaning to heavier weights revealed results similar to those of the cow-calf study. Economies associated with size in this operation were more apparent. Large herds had a cost of \$132 per calf or \$23.49 per hundredweight of beef added. Medium herds had a cost of \$138 per calf or \$32.31 per hundredweight added. Small herds had a cost of \$151 per calf or \$50.01 per hundredweight added.

Returns above total cost were positive only for the large herds at \$0.38 per calf. Losses were \$13.51 per calf for medium herds and \$26.45 per calf for small herds.

Returns above operating cost were \$1.57 for large herds and losses were \$10.04 and \$23.54 for medium and small herds, respectively. Prices for the animals fed followed the usual pattern of declining for heavier animals by declining from an initial value of \$24.89 per hundredweight before feeding to \$23.68 per hundredweight after being fed. The average weight of the calves selected to hold past weaning was only 44 pounds per calf lighter than that of all calves sold directly by the 215 producers. Less than 186 pounds were added per calf.

Results of the holding operations phase of the study cannot be deemed conclusive because of the small number of respondents — only 46 of the 215 producers interviewed reported holding calves past weaning weights. The results do, however, point to the need for further economic research on the feasibility of carrying calves to heavier-than-weaning weights.

COSTS AND RETURNS FROM BEEF CATTLE IN THE BROWN LOAM AREA OF MISSISSIPPI

By

I. P. BOX, Jr., R. J. MARTIN, and T. D. PHILLIPS*

Once a "sideline" enterprise in this state, beef cattle production has become one of the major contributors to the incomes of Mississippi farmers. The number of beef animals on Mississippi farms has more than doubled within the past two decades (2).¹ Cash receipts from farmer sales of cattle and calves in 1967 amounted to about \$136 million — 17.4 percent of the state's farm marketing total (4).

In 1967 about 40 percent of Mississippi's cattle were being produced in the Brown Loam Area, a forty- to fifty-mile wide strip of loessial soils running the length of the state just east of the Delta. Typically, beef cattle enterprises in that area are those known as "cow-calf" operations, in which grade calves are produced for marketing at weaning — or, less commonly, are held past weaning for sale at heavier weights. Little current information is available on expected costs and returns from investments in beef cattle herds. A 1954 study of beef cattle systems in South Mississippi (3) provided information on "resources used in beef production and investment required, costs and returns involved, and management practices and their effect on costs and returns." A 1965 study (1) examined "the place of cow-calf enterprises in farming systems in the Yazoo-Mississippi Delta." That

research, however, was aimed primarily at evaluating optimum allocation of different sods on selected soil types.

The research reported herein describes the costs and returns for a sample of beef producers classified by selected characteristics. Its specific objectives were:

1. To estimate costs and returns from cow-calf operations of different sizes, and
2. To estimate costs and returns of feeding calves held past weaning.

At the suggestion of the Mississippi Cattlemen Association nine counties in the Brown Loam Area were selected as the locus of a survey of cow-calf enterprises. On the assumption that pasture practices and land value—and, therefore, production costs—in one end of the belt would differ significantly from those in the other, three subareas were delineated. Survey counties selected in each subarea were: Benton, Marshall, and Tate in the North; Grenada, Holmes, Madison, and Yazoo in the Central; and Claiborne and Wilkinson in the South.

County Extension Agents in the nine counties developed lists of cow-calf operators whose herds contained thirty or more grade brood cows. These lists were stratified by size of herd. Size classifications used were: Small, 30-50 brood cows; Medium, 51-100; and Large, more than 100 brood cows.² An attempt was made to obtain, by personal interview, data on July 1, 1966 — June 30, 1967 operations of at least ten respondents in each size class in each of the nine sample counties. Interviews resulted in 215 useable schedules, 78 from the North, 97 from the Central, and 40 from the Southern subareas. Forty-six of the 215 respondents reported holding calves for sale at heavier - than - weaning weights.

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¹Numbers in parentheses refer to sources listed in bibliography.

²Cow numbers used were averages of beginning-of-year and end-of-year inventories. Thus, in some instances, stratification could not be accomplished prior to a producer interview.

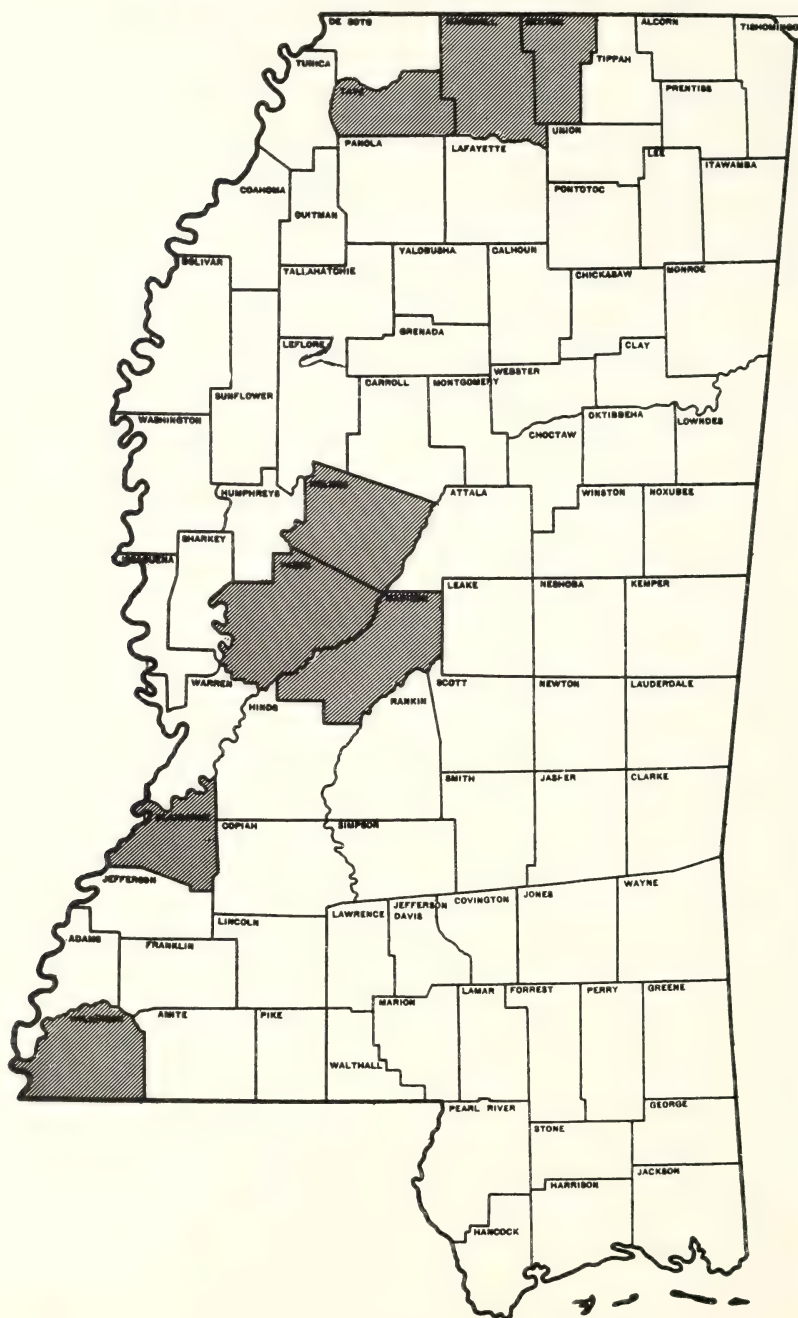


Figure 1. Counties studied, Brown Loam Area, Mississippi 1966-67.

This report presents, first, an analysis for the entire 215 enterprises. Then, to indicate cost differences attributable both to size and to location, similar analyses for each size class, by subarea, are reported. Finally, the enterprises of the 46 respondents who marketed calves held past weaning are analyzed, also by size class.

Prices used in developing cost estimates are those that prevailed in the area in 1966-67. Inputs, prices, and details of cost-estimating procedures used are set forth in the Appendix. Prices used in estimating the value of cattle and calf sales are averages of those reported by respondents.

COST AND RETURNS FROM ALL COW-CALF OPERATIONS

The following discussion presents an overview of the 215 operations in the sample. Its purpose is simply to afford a broad, general view of cow-calf enterprises as they existed in the survey areas in 1966-67, without regard to differences attributable to size or location.

Characteristics of Farms

The average age of the 215 producers interviewed was 51 years. Only 10 percent of the farmers reported beef cattle production as their main source of income; 54 percent listed a combination of row crops and beef cattle; for 26 percent, the greater part of their incomes came from non-farm businesses and off-farm employment; and the other 10 percent reported combinations of crops, beef, and off-farm employment.

An average of 303 acres per farm, valued at approximately \$200 per acre, was devoted to permanent pasture. An additional 191 acres of woodland with an average rental value of \$0.99 per acre were used for grazing purposes by cow-calf enterprises. Ten producers reported that at least a part, and three reported that all, of their grazing land was rented from other farms.

The number of brood cows per farm averaged 102 head, valued at \$16,551. An average of 74 calves, valued at \$5,408, was on hand. An inventory of 4 bulls, valued at \$1,686, and 11 heifers, valued

at \$1,367, brought the average beef cattle inventory to a total of 191 head, valued at about \$25,000 (Table 1).

Costs

With labor charged at the prevailing minimum wage rate of \$1.00 per hour, production costs per calf on hand averaged \$130.55, Table 2.³

Operating costs constituted 78 percent of total costs before adjusting for inventory changes and breeding cattle purchases. Feed, permanent pasture, and temporary grazing costs accounted for 68 percent of total operating costs. Labor costs made up 17 percent of operating costs. Interest on herd investment accounted for more than half the overhead costs and about one-eighth of total costs.

Returns

During the year respondents had on hand an average of almost 74 calves per farm (Table 3). Sales averaged 73 calves for an average weight of 394 pounds per calf. At a price of \$24.23, these calves brought about \$95.50 each. Sales of culled breeding stock — averaging 10,338

³Because of varying inventory number of calves, costs and returns were estimated on basis of average calves on hand, rather than the number marketed, in order to more realistically reflect calf production.

pounds per farm at \$16.69 per hundredweight — afforded an additional source of income from livestock. Purchases of replacements, however, sharply reduced the amount realized from that source. The average producer grossed \$8,715.47 from the sale of calves and cull

Table 1. Average beef cattle inventory and interest on investment, 215 producers, Brown Loam Area, Mississippi, 1966-67.

Item	No.	Average all sizes Value (dollars)
Farm	215	XX
Brood cows	101.5	16,551.16
Cull bulls	0.2	47.11
Breeding bulls	4.2	1,638.47
Repl. heifers	10.9	1,366.80
Calves	73.7	5,408.13
Total inventory	190.5	25,011.67
Interest on investment ^a	XX	1,176.21

^aCalculated at 6 percent of value of breeding stock only.

Table 2. Costs per calf on hand, 215 producers, Brown Loam Area, Mississippi, 1966-67.

Item	Average all sizes
Average number brood cows	101.5
Average number calves on hand	73.7
Number of calves marketed	73.3
Cwt. calves sold per farm	288.54
Cwt. beef sold per farm	391.92
Cost per calf on hand of:	-- dollars --
Operating costs:	
Feed	42.18
Labor for daily chores	10.87
Other labor ^a	6.16
Permanent pasture	15.75
Transportation	7.88
Temporary grazing	11.66
Commission on sales	4.19
Veterinary & medicine	1.99
Miscellaneous	1.27
Total operating cost ^b	101.95
Overhead:	
Interest on herd investment	15.95
Fencing	5.35
Buildings	5.26
Property tax	1.32
Specialized equipment	.72
Total overhead cost	28.60
Total cost (operating & overhead)	130.55
Less change in inventory ^c	30.35
Plus purchases ^d	18.92
Adjusted total cost	119.12
Cost per cwt. of calves mkt.	38.20

^aIncludes labor for permanent pasture, temporary grazing, buildings, and fencing.

^bExcludes land charge for permanent pasture and woodland grazing.

^cWhen beginning of the year price was used, this value was \$6.59.

^dPrimarily breeding stock.

Table 3. Returns from production of beef calves, 215 producers, Brown Loam Area, Mississippi, 1966-67.

Item	Average all sizes
Average number of brood cows	101.5
Average number calves on hand	73.7
Number calves marketed	73.3
Lbs. calves marketed, cwt.	288.54
Lbs. all beef marketed, cwt.	391.92
Avg. price of calves sold \$/cwt.	24.23
Cash receipts: ^a	-- dollars --
Calf sales	6,990.30
Breeding stock sales	1,725.17
Change in inventory ^b	2,238.00
Total credits per farm	10,953.47
Costs:	
Operating	7,517.94
Overhead	2,109.28
Purchases ^c	1,395.33
Total cost per farm ^d	11,022.55
Returns above total costs: ^d	
Per farm	-69.08
Per calf on hand	-.94
Returns above operating cost:	
Per farm	2,040.20
Per calf on hand	27.68
Returns above operating cost less labor costs:	
Per farm	3,295.31
Per calf on hand	44.71

^aPlus ASC payments listed by size and county, Appendix Table 3.^bWhen beginning of the year price was used, this was \$486.20.^cPrimarily breeding stock.^dExcludes land charge for permanent pasture and woodland grazing.**Table 4. Selected characteristics, by size, 215 producers, Brown Loam Area, Mississippi, 1966-67.**

Factor	Unit	Size			Average all sizes
		Small	Medium	Large	
Calves born per cow	Pct.	86.9	86.3	82.7	84.0
Calves sold per cow	Pct.	74.6	77.2	69.9	72.2
Calves sold per calf born	Pct.	85.9	89.4	84.6	85.9
Mortality rate of calves	Pct.	3.9	3.2	2.5	2.8
Average weight of calves sold	Lbs.	398.1	394.1	393.0	398.8
Permanent pasture	A/Farm	118.4	220.9	534.3	303.1
Woodland pasture	A/Farm	84.3	117.2	345.9	191.0
Stocking rate of permanent pasture	A/Cow	3.27	3.14	2.88	2.99
Stocking rate of woodland pasture	A/Cow	2.33	1.67	1.87	1.87
Market value permanent pasture	\$/A	186.0	208.0	200.0	199.0
Rental value woodland grazing	\$/A	0.58	1.07	1.24	0.99

animals. In addition, his herd grew in value by \$2,238 during the year. Thus total credits to the cow-calf enterprise were \$10,953.47—not counting payments for carrying out ASCS approved pasture practices. (On some of the larger farms these payments may have exceeded \$1,000.)

With a gross of \$10,953.47 and total costs of \$11,022.55, the average farmer lost \$69.08 on his year's operation. Losses averaged about \$.94 per calf.

But if fixed costs (charges for such items as buildings, equipment, taxes, and interest) are not considered, the story is somewhat different. Returns above operating costs, after adjusting for breeding stock purchases, averaged \$2,040.20 or \$27.68 per calf. And, if no charge is made for labor, these returns average \$44.71 per calf.

Factors Affecting Costs

The next section describes in detail the variation in costs and returns associated with size and location within the Brown Loam area. Additional background data associated with size and practices are presented in this section.

Although a higher proportion of the cows on smaller farms produced calves, the mortality rate was lower for the larger producers (Table 4). Calf weights were essentially the same for all sizes. Although calves sold per cow was lower

for large producers, the larger producers used less acres per cow.

Producers estimated the market value of their land used as permanent pasture at almost \$200 per acre.⁴ The estimated rental value of woodland used for grazing varied from \$0.58 per acre for the small producers to \$1.24 per acre for the large group.

To attempt to detect differences in costs and returns from various practices, the data were sorted into groups depending upon whether a producer did or not follow a selected practice. Items selected were saving hay from pastures, feeding silage, grazing crop residues, and using temporary grazing. If a farmer followed one of the practices, it was not determined whether he did or did not follow any of the other three.

Although no specific conclusions can be drawn about a particular practice, interesting questions are posed by the findings (Table 5). Further research is needed to probe into the economics of which practices will likely be profitable.

⁴See Appendix Table 6 for acreages of permanent pasture and woodland grazed and farmers' estimates of values by size and area.

Table 5. Effect of selected practices on costs and returns, 215 cow-calf operations, Brown Loam Area, Mississippi, 1966-67.

Management System	No. Farms	Total Credits ^a	Total Costs ^b	Differences
Save hay from pasture	72	149.63	140.80	8.83
Save no hay from pasture	143	148.14	155.47	-7.33
Fed Silage	32	151.27	140.94	10.33
Fed no silage	183	147.87	151.67	-3.80
Grazing crop residue	145	148.94	147.26	1.68
Grazing no crop residue	70	148.06	152.58	-4.52
Temporary grazing	125	151.93	154.36	-2.43
No temporary grazing	90	142.19	140.26	1.93

^aIncludes value of all sales and change in value of inventory.

^bIncludes all operational and fixed costs plus any purchases.

COSTS AND RETURNS FROM COW-CALF OPERATIONS OF DIFFERENT SIZES

The analyses by size group are presented in much the same manner as was the discussion of the overall average of the 215 sample operations. In addition, data for each of the three size categories are presented by sub-areas, to point up locational differences.

SMALL HERDS

Characteristics of Farms

A total of 63 usable schedules was obtained from those farmers who owned an average of from 30 to 50 head of brood cows.

The average age of producers with small herds was 53 years. Approximately 44 percent of these farmers reported something other than farming as a primary source of income — a majority of these listed non-farm businesses and professions. Of the remaining producers 43 percent listed crops and beef as a main source of income; 8 percent listed beef production alone; and 5 percent were engaged in combinations of farm enterprises and off-farm employment.

Permanent pasture acreage used per farm averaged 118 acres. Additionally, 84 acres of woodland were grazed per farm. Open pastures in the northern area tended to be larger than those in the

other two areas. Woodland pastures in the southern area were, on the average, larger than those in either the northern or central areas (Appendix Table 6).

The average size herd was 68 animals — 36 brood cows valued at \$5,752; 26 calves valued at \$1,852; 4 heifers valued at \$483; and 2 bulls valued at \$570 (Table 6). Farmers in the southern area reported fewer calves on hand per cow than did the other producers.

Costs

The sampled small producers reported production costs of \$151 per calf before adjusting for purchases and change in inventory value (Table 7). Adjustments reduced the cost of \$140, excluding land charges for pasture. Operating costs accounted for 84 percent of the adjusted total cost. Feed and grazing cost compose 62 percent of the operating costs and over 50 percent of the adjusted total cost. Labor costs were 22 percent of operating costs. About 45 percent of the overhead cost was composed of interest on herd investment. An average of \$19.13 per calf was spent on breeding stock purchases and each herd was credited \$30.63 per calf for increases in inventory value.

There was very little difference in costs of various items between the northern

Table 6. Average beef cattle inventory and interest on inventory, 63 small herds, by subarea, Brown Loam Area, Mississippi, 1966-67.

Item	Area				Average			
	North		Central		South		all areas	
	No.	Value(dollars)	No.	Value(dollars)	No.	Value(dollars)	No.	Value (dollars)
Farms	29	XX	26	XX	8	XX	63	XX
Brood Cows	37.40	6,427.66	34.30	5,175.74	38.30	5,176.69	36.20	5,752.14
Cull bulls	0.03	8.53	0.00	0.00	0.10	22.38	0.03	6.77
Breeding bulls	1.80	697.83	1.40	458.81	1.20	418.75	1.60	563.75
Repl. heifers	4.20	518.79	4.00	486.76	3.30	338.75	4.00	482.71
Calves	28.80	2,129.35	24.20	1,603.47	22.90	1,656.09	26.10	1,852.22
Total inventory	72.23	9,782.16	63.90	7,724.78	65.80	7,612.66	67.93	8,657.59
Interest on investment ^a	XX	458.24	XX	367.23	XX	357.39	XX	407.87

^aCalculated at 6 percent of value of breeding stock only.

Table 7. Costs per calf on hand, small herds, 63 producers, by subarea, Brown Loam Area, Mississippi, 1966-67.

Item	Area			Average all areas
	North	Central	South	
Number of farms	29	26	8	—
Average number of brood cows	37.4	34.3	38.3	36.2
Average number of calves on hand	28.8	24.2	22.9	26.1
Cost per calf on hand of:	dollars			
Operating costs:				
Feed	49.09	43.46	36.88	45.67
Labor for daily chores	16.31	16.95	25.41	17.60
Other labor ^a	8.64	7.79	9.49	8.42
Permanent pasture	15.86	19.74	15.22	17.31
Transportation	10.87	9.59	13.56	10.70
Commission on sales	4.63	4.05	5.05	4.47
Temporary grazing	7.47	9.68	14.13	9.07
Veterinary & medicine	2.16	2.32	2.57	2.27
Miscellaneous	1.17	2.03	.37	1.41
Total operating costs ^b	116.20	115.61	122.68	116.92
Overhead:				
Interest on herd investment	15.94	15.18	15.60	15.63
Buildings	8.91	8.66	7.84	8.72
Fencing	8.34	7.35	8.32	7.98
Property tax	1.50	1.38	1.47	1.45
Specialized equipment	.42	1.08	.61	.69
Total overhead costs	35.11	33.65	33.84	34.47
Total cost (operating & overhead) ^b	151.31	149.26	156.52	151.39
Less change in inventory ^c	38.79	18.92	33.14	30.63
Plus purchases ^d	26.83	8.59	19.84	19.13
Adjusted total cost ^b	139.35	138.93	143.22	139.89

^aIncludes labor for permanent pasture, temporary grazing, buildings, and fencing at \$1/hr.

^bExcluding land charge for permanent pasture and woodland grazing.

^cWhen beginning of the year price was used, these values were \$23.95, -\$6.50, -\$9.94, and \$7.15, respectively.

^dPrimarily breeding stock.

and central producers. Southern producers, however, spent more per calf on labor, temporary grazing, and transportation but less on feed than producers in the central and northern areas.

Returns

The small producers had an average of 26 calves for sale during the year (Table 8). At a selling price of \$24.15 per hundredweight for those sold, the value of calf production was \$2,596. Sales of nearly 37 hundredweights of cull breeding stock added another \$573 to receipts; however, purchases of replacement breeding stock cost \$499. An increase in inventory of \$800 brought total credits per farm to \$3,969.

The northern counties were noticeably higher in value of calves produced, increase in value of inventory, and purchases, but about in line with the other two areas on breeding stock sales.

On average small producers were not able to cover total costs—losses ranged from \$11.34 per calf in the north to \$27.53 in the central area. However, when overhead was excluded producers in all areas had positive returns above operating costs. When labor was excluded, returns averaged \$42 per head for the small producers. Using this method to measure returns, the northern and southern area showed essentially the same returns at \$49, while producers in the central area had less than \$31 per head.

Table 8. Returns from production of beef calves, small herds, 63 producers, by subarea, Mississippi, 1966-67.

Item	Area			Average All areas
	North	Central	South	
Number of farms	29	26	8	63
Average number brood cows	37.4	34.3	38.3	36.2
Average number calves on hand	28.8	24.2	22.9	26.1
Number calves marketed	30.6	23.5	25.4	27.0
Lbs. calves marketed, cwt.	129.32	87.86	92.14	107.49
Lbs. all beef marketed, cwt.	162.40	128.61	129.31	144.26
Avg. price of calves sold, \$/cwt.	24.17	23.69	25.43	24.15
Cash receipts: ^a	dollars			
Cash sales	3,126.05	2,081.63	2,342.94	2,595.58
Breeding stock sales	560.90	613.98	486.31	573.34
Change in inventory ^b	1,117.29	457.77	758.94	799.60
Total credits per farm	4,804.24	3,153.38	3,588.19	3,968.52
Costs:				
Operating	3,346.97	2,798.22	2,809.81	3,052.28
Overhead	1,011.09	814.05	775.12	899.36
Purchases ^c	772.72	207.85	454.38	499.18
Total costs per farm	5,130.78	3,820.12	4,039.31	4,450.82
Returns above total costs: ^d				
Per farm	-326.54	-666.24	-451.12	-482.30
Per calf on hand	- 11.34	- 27.53	- 19.70	- 18.48
Returns above operating costs:				
Per farm	684.55	147.31	324.00	417.06
Per calf on hand	23.77	6.09	14.14	15.98
Returns above operating costs less labor costs:				
Per farm	1,403.11	746.02	1,123.21	1,096.18
Per calf on hand	48.72	30.83	49.05	42.00

^aPlus ASC payments listed by size and county, Appendix Table 3.

^bWhen beginning of the year price was used, these values were \$689.72, -\$157.42, -\$227.61, and \$186.69, respectively.

^cPrimarily breeding stock.

^dExcludes land charge for permanent pasture and woodland grazing.

MEDIUM HERDS

Characteristics of Farm

The sample of producers with medium sized herds included 25 from the northern area, 34 from the central area, and 16 from the southern area.

The average age of producers in this size group was 52 years. Of these farmers 47 percent reported that their income came from crops and beef in almost equal proportions. The main source of income for 31 percent was off-farm employment. Only 11 percent reported their beef

operation as the main source of income. Also, 11 percent reported beef production and off-farm activities sharing equally in providing an income.

The medium herds grazed an average of 221 acres of permanent pasture. Additionally 117 acres of woodland pasture was grazed (Appendix Table 6).

The average medium herd consisted of 134 animals valued at \$16,573. The herds were comprised of 70 brood cows, 3 bulls, 8 replacement heifers, and 53 calves (Table 9).

Table 10. Costs per calf on hand, medium herds, 75 producers, by subarea, Brown Loam Area, Mississippi, 1966-67.

Item	Area			Average
	: North	: Central	: South	: all areas
Number of farms	25	34	16	—
Average number brood cows	70.8	70.0	70.5	70.4
Average number calves on hand	54.4	52.5	49.9	52.6
Costs per calf on hand of:	----- dollars -----			
Operating costs:				
Feed	50.71	44.72	48.23	47.49
Labor for daily chores	13.92	10.62	16.15	12.88
Other labor ^a	7.71	6.93	7.24	7.26
Permanent pasture	20.66	21.84	7.00	18.42
Transportation	11.23	7.62	14.88	10.34
Temporary grazing	17.08	11.57	22.30	15.65
Commission on sales	4.42	3.62	5.54	4.29
Veterinary & medicine	2.33	2.16	2.25	2.24
Miscellaneous	1.92	1.46	1.34	1.59
Total operating costs ^b	129.98	110.54	124.93	120.16
Overhead:				
Interest on herd investment	15.31	14.38	14.27	14.67
Buildings	7.71	6.56	5.64	6.76
Fencing	7.09	5.93	6.84	6.51
Property tax	1.36	1.30	1.37	1.39
Specialized equipment	.58	.57	1.72	.81
Total overhead costs	32.05	28.74	29.84	30.14
Total cost (operating & overhead) ^b	162.03	139.28	154.77	150.30
Less change in inventory ^c	45.53	23.50	36.61	33.74
Plus purchases ^d	36.99	19.67	28.82	26.54
Adjusted total cost ^b	153.49	135.45	146.98	143.10

^aIncludes labor for permanent pasture, temporary grazing, buildings, and fencing at \$1/hr.

^bExcluding land charge for permanent pasture and woodland grazing.

^cWhen beginning of the year price was used, these values were \$15.72, \$.10, -\$1.86, and \$4.63, respectively.

^dPrimarily breeding stock.

Costs

Very little difference was found between producers with medium and small herds in the allocation of expenses among the items which formed the total costs. Farmers with medium sized herds reported costs of only \$1.09 per calf less than did farmers with small herds before adjustments. After adjusting for inventory changes and purchases, owners of medium herds reported an average cost per calf on hand of \$143.10 — \$3.21 higher than producers with small herds (Table 7 and 10). This implies that there were few, if any, economies associated with increasing the size of the herd from 36 brood cows to 70 brood cows.

Returns

Producers in the medium size category had an average of almost 53 calves on hand during the year (Table 11). Slightly over 54 calves were sold per farm. This group of farmers experienced an average loss of \$16.90 per head, but losses varied widely among the regions of the Brown Loam Area. Although farmers in the northern area received a higher price for their calves, they averaged losses of \$30.21 while producers in the central average lost only \$7.98. Much of this difference can be accounted for by purchases of breeding stock exceeding sales in the northern area while sales exceeded purchases in the South.

Table 9. Average beef cattle inventory and interest on inventory, 75 medium herds, by subarea, Brown Loam Area, Mississippi, 1966-67.

Item	Area				Average	
	North		Central		all areas	
	No.	Value (dollars)	No.	Value (dollars)	No.	Value (dollars)
Farms	25	XX	34	XX	16	75
Brood cows	70.8	11,685.94	70.0	10,529.23	70.5	10,198.91
Cull bulls	0.2	54.65	0.1	22.02	0.3	49.97
Breeding bulls	2.9	1,013.40	2.9	1,028.44	2.6	909.38
Repl. Heifers	8.3	1,125.45	8.6	1,009.43	6.0	709.19
Calves	54.4	4,032.30	52.5	3,538.71	49.9	3,560.17
Total inventory	136.6	17,911.74	134.1	16,127.03	129.3	15,427.62
Interest on investment ^a	XX	832.77	XX	755.35	XX	712.05
					XX	771.92

^aCalculated at 6 percent of value of breeding stock only.

Table 12. Average beef cattle inventory and interest on inventory, 77 large herds, by subarea, Brown Loam Area, Mississippi, 1966-67.

Item	Area				Average	
	North		Central		all areas	
	No.	Value (dollars)	No.	Value (dollars)	No.	Value (dollars)
Farms	24	XX	37	XX	16	77
Brood cows	178.0	29,397.04	184.1	32,267.11	199.1	30,212.13
Cull bulls	0.2	40.21	0.4	96.86	0.5	139.94
Breeding bulls	7.0	2,669.56	7.1	3,083.23	9.4	3,984.56
Repl. heifers	15.3	1,933.77	21.2	2,713.35	21.7	2,677.66
Calves	130.5	10,092.02	135.1	9,763.99	132.1	10,281.23
Total inventory	331.0	44,132.60	347.9	47,924.54	362.8	47,295.52
Interest on investment ^a	XX	2,042.43	XX	2,289.63	XX	2,220.86
					XX	2,198.41

^aCalculated at 6 percent of value of breeding stock only.

Table 11. Returns from production of beef calves, medium herds, 75 producers, by subarea, Brown Loam Area, Mississippi 1966-67.

Item	Area			Average
	North	Central	South	all areas
Number of farms	25	34	16	75
Average number brood cows	70.8	70.0	70.5	70.4
Average number calves on hand	54.4	52.5	49.9	52.6
Number calves marketed	55.0	54.7	52.5	54.3
Lbs. calves marketed, cwt.	217.70	215.22	205.79	214.03
Lbs. all beef marketed, cwt.	305.28	313.84	296.93	307.38
Avg. price of calves sold, \$/cwt.	24.33	23.47	23.87	23.85
Cash receipts: ^a				
Calf sales	5,297.02	5,050.88	4,913.61	5,103.64
Breeding stock sales	1,410.66	1,644.84	1,494.00	1,534.60
Change in inventory ^b	2,477.07	1,234.29	1,826.84	1,774.96
Total credits per farm	9,184.75	7,930.01	8,231.45	8,413.20
Costs:				
Operating	7,071.71	5,806.41	6,235.05	6,319.63
Overhead	1,743.58	1,509.56	1,489.09	1,586.27
Purchases ^c	2,012.77	1,033.24	1,438.31	1,396.17
Total costs per farm	10,828.06	8,349.21	9,162.45	9,302.07
Returns above total costs: ^d				
Per farm	-1,643.31	-419.20	-931.00	-888.87
Per calf on hand	- 30.21	- 7.98	- 18.66	- 16.90
Returns above operating costs:				
Per farm	100.27	1,090.36	558.09	697.40
Per calf on hand	1.84	20.77	11.18	13.26
Returns above operating cost less labor costs:				
Per farm	1,176.67	2,011.74	1,725.25	1,756.76
Per calf on hand	21.63	38.32	34.57	33.40

^aPlus ASC payments listed by size and county, Appendix Table 3.^bWhen beginning of the year price was used, these values were \$855.54, \$171.94, -\$93.04, and \$243.57, respectively.^cPrimarily breeding stock.^dExcludes land charge for permanent pasture and woodland grazing.

However, producers in the northern area did slightly more than cover operating costs. Returns above operating costs averaged \$13.26 per calf. Deducting labor costs, returns increased slightly more than \$20 per head more to \$33.40 per head for medium producers.

Comparing returns above total costs for the small and medium producers, very little difference existed on average (Tables 8 and 11). Returns above operating costs for medium producers were only \$13.26 compared with \$15.98 for the small group. However, because the smaller producers used more labor per calf, returns excluding labor were \$8.60

per calf higher for producers of the small herds.

LARGE HERDS

Characteristics of Farms

Of the total sample, 77 producers averaged owning more than 100 brood cows. On the average the producer with a large herd was slightly younger than those who owned fewer head of cattle; the average age was 49. The beef enterprise alone furnished a majority of the income for 13 percent of the producers with large herds. A balance of crops and livestock provided 69 percent with their major cash inflows. Only 14 percent reported

Table 13. Costs per calf on hand, large herds, 77 producers, by subarea, Brown Loam Area, Mississippi 1966-67.

Item	Area			Average : all areas
	: North	: Central	: South	
Number of farms	24	37	16	—
Average number brood cows	178.0	184.1	199.1	185.3
Average number calves on hand	130.5	135.1	132.1	133.1
Costs per calf on hand of:	----- dollars -----			
Operating costs:				
Feed	34.39	43.05	39.45	39.63
Labor for daily chores	9.16	8.91	9.13	9.03
Other labor ^a	4.57	5.57	6.12	5.38
Permanent pasture	14.64	13.19	17.39	14.49
Transportation	5.46	6.79	7.35	6.50
Temporary grazing	7.90	10.52	14.60	10.55
Commission on sales	4.68	3.50	4.70	4.11
Veterinary & medicine	1.52	2.03	1.96	1.86
Miscellaneous	1.56	1.13	.58	1.14
Total operating costs ^b	83.88	94.69	101.28	92.69
Overhead:				
Interest on herd investment	15.65	16.94	16.81	16.51
Fencing	3.93	4.39	5.58	4.49
Buildings	2.51	4.93	4.66	4.13
Property tax	1.36	1.14	1.51	1.28
Specialized equipment	.77	.28	1.57	.69
Total overhead cost	24.22	27.68	30.13	27.10
Total cost (operating & overhead) ^b	108.10	122.37	131.41	119.79
Less change in inventory ^c	27.81	30.61	27.20	29.03
Plus purchases ^d	18.05	14.03	17.62	15.99
Adjusted total costs ^b	98.34	105.79	121.83	106.75

^aIncludes labor for permanent pasture, temporary grazing, buildings, and fencing at \$1/hr.

^bExcluding land charge for permanent pasture and woodland grazing.

^cWhen beginning of the year price was used, these values were \$4.07, \$14.22, \$2.72, and \$7.31, respectively.

^dPrimarily breeding stock.

off-farm sources, and 4 percent reported a combination of farm and off-farm sources.

A range of from 482 to 625 acres was devoted to permanent pasture in the areas studied with 534 being the average used. An additional 346 acres of woodland was grazed (Appendix Table 6).

On the average large producers had 185 brood cows on hand, valued at \$167 each (Table 12). In addition large producers owned 18 bulls and 20 replacement heifers valued at \$3,230 and \$2,463, respectively. They also carried an average of 133 calves on hand valued at \$9,974.

Costs

When the average number of brood cows per farm was increased from 70 to 185, average cost per calf on hand was reduced by \$36.35 per head (Tables 10 and 13). Producers with large herds in each respective area produced calves at a lower cost per head than did farmers with small and medium herds (Tables 7, 10, and 13.)

Feed, permanent pasture and temporary grazing made up 70 percent of operating costs or 54 percent of total costs (Table 13). Labor was the other major item of operating cost at \$14.41

Table 14. Returns from production of beef calves, large herds, 77 producers, by subarea, Brown Loam Area, Mississippi 1966 - 67.

Item	Area			Average : all areas
	: North	: Central	: South	
Number of farms	24	37	16	—
Average number of brood cows	178.0	184.1	199.1	185.3
Average number calves on hand	130.5	135.1	132.1	133.1
Number calves marketed	129.5	124.7	140.9	129.6
Lbs. calves marketed, cwt.	495.19	497.15	558.33	509.25
Lbs. all beef marketed, cwt.	664.96	622.62	820.28	676.89
Avg. price of calves sold, \$/cwt.	25.17	24.15	23.88	24.40
Cash receipts: ^a	dollars			
Calf sales	12,466.04	12,003.83	13,331.06	12,423.68
Breeding stock sales	3,112.96	2,128.53	4,139.36	2,853.20
Change in inventory ^b	3,630.95	4,136.31	3,592.85	3,865.87
Total credits per farm	19,209.95	18,268.67	21,063.27	19,142.75
Costs:				
Operating	10,950.45	12,794.85	13,380.09	12,341.56
Overhead	3,160.80	3,742.12	3,978.81	3,613.22
Purchases ^c	2,356.17	1,896.46	2,327.94	2,129.40
Total costs per farm	16,467.42	18,433.43	19,686.84	18,084.18
Returns above total cost: ^d				
Per farm	2,742.53	-164.76	1,376.43	1,058.57
Per calf on hand	21.02	-1.22	10.42	7.95
Returns above operating cost:				
Per farm	5,903.33	3,577.36	5,355.24	4,671.79
Per calf on hand	45.24	26.48	40.54	35.10
Returns above operating costs less labor costs:				
Per farm	7,695.09	5,533.61	7,369.76	6,588.76
Per calf on hand	58.97	40.96	55.79	49.51

^aPlus ASC payments listed by size and county, Appendix Table 3.

^bWhen beginning of the year price was used, these values were \$531.86, \$1,921.66, -\$359.83, and \$972.74, respectively.

^cPrimarily breeding stock.

^dExcludes land charge for permanent pasture and woodland grazing.

per head. Interest on the herd made up over 60 percent of overhead costs.

The northern area had lowest costs per head in most categories. The southern area ranked second highest in feed costs but highest in permanent pasture and temporary grazing costs. Feeding costs—feed, permanent pasture, and temporary grazing—ranged from \$56.93 in the north to \$71.44 in the southern area.

Returns

On average producers with large herds experienced a positive return over total costs (Table 14). However, producers in the central area lost \$165 per farm or \$1.22 per calf.

An average of 133 calves were on hand during the year while sales averaged almost 130 head per farm. Producers sold an average of 509 hundredweights of calves and 168 hundredweights of cull breeding animals per farm. Sales of cull breeding stock exceeded purchases by \$724 per farm.

Offsetting relatively high costs of production in the southern area was heavy sales of breeding stock. Sales of these animals exceeded purchases by \$1,811 per farm. Calf sales were higher in this area also. In spite of the lower price, gross receipts were higher than for the other areas.

Returns above total costs averaged \$7.95 per calf and ranged from the \$1.22 loss in the central area to \$21.02 above costs in the north. Returns above

operating costs were \$35.10 after adjusting for purchases. Ignoring labor costs, returns averaged almost \$50 per head.

COST AND RETURNS FROM HOLDING OPERATIONS

Increasing the total pounds of beef marketed can be accomplished by either increasing the number of calves produced or by increasing the weight of calves marketed. Of the 215 producers interviewed, 46 reported holding calves past weaning weight to increase the volume of beef marketed. These holding operations were separated from the cow-calf operations and studied as individual enterprises. Only differences in size of operation were considered because of the limited number of observations by both size and location.

The method of cost calculation was same as used in estimating the costs involved in the cow-calf operations. Again costs were assessed on a per calf basis. Only the actual value added by the holding operation was considered when determining the returns above operating costs. The end of the accounting period was at a time of the year soon after all of the calves held had been marketed or where marketing was imminent for those on hand.

Therefore, the actual pounds of beef sold or slaughtered for home use and the receipts from these transactions plus the estimated weight and value of the calves still on hand were combined in calculating the total credits added by this enterprise.

This figure (total credits) was then reduced by the producer's estimate of the value of the calves at the time they were bought or transferred from the cow-calf operation to estimate the actual value and weight added by holding. In estimating returns above total costs, all costs except a charge for land used for permanent pasture were subtracted from the total credits accrued by holding these calves.

Costs

The total cost of holding past weaning averaged \$46.28 per calf (Table 15). Operating costs were 97 percent of the total cost before the value of the animal was considered. The cost of providing temporary grazing was \$21.89 per calf — almost one-half of the total. The cost of permanent pasture, feed, and temporary grazing combined made up 77 percent of the total cost. Buildings accounted for the largest single share of the overhead cost. The average total cost for adding one hundred pounds of beef was \$24.93.

Farms that held calves past weaning had larger herds than those that did not. Those with holding operations on the average had 143 brood cows compared to 90 brood cows for those who did not hold. Those holding calves devoted 365 acres to permanent pasture to 282 for those not holding. Of the 46 producers who reported holding calves past weaning, 6 had small, 12 medium, and 28 large herds (Table 15).

Very little pasture land was devoted to the holding operation. On the average 17.9 acres were used at a value of \$219.09 per acre. In addition 6.9 acres of woodland, with a rental value for grazing of \$1.11 per acre, was grazed.

Returns

On the average holding calves past weaning was not profitable when all costs were considered (Table 16). Average losses amounted to \$159.96 per farm or \$2.20 per calf. These losses averaged \$1.19 per hundredweight added by holding beyond weaning. One factor contributing to these losses was a drop in calf prices during the holding period.

Table 15. Costs per calf held past weaning weight, 46 producers, by herd size, Brown Loam Area, Mississippi, 1966-67.

Item	Herd size			Average all sizes
	Small	Medium	Large	
Number of farms	6	12	28	
Average number of calves held	21.8	30.8	101.5	72.7
Average initial weight	396	354	347	350
Average initial value, \$/cwt.	23.61	24.88	25.01	24.89
Lbs. added by holding, per calf	114.1	154.0	193.1	185.6
Avg. cwt. beef added per farm	24.88	47.43	196.08	134.97
Costs per calf held of:	----- dollars -----			
Operating costs:				
Feed	23.85	24.75	10.83	12.87
Temporary grazing	16.54	10.50	23.63	21.89
Labor for daily chores	6.02	2.85	2.07	2.31
Other labor ^a	2.38	1.34	1.76	1.75
Transportation	2.60	4.01	2.20	2.41
Permanent pasture	1.56	1.49	1.01	1.08
Commission on sales	.93	.83	1.53	1.43
Veterinary & medicine	.20	.33	.84	.76
Miscellaneous	.07	.60	.30	.33
Total operating costs	54.15	46.70	44.17	44.83
Overhead costs:				
Buildings	2.44	1.90	.43	.66
Specialized equipment	.00	.60	.47	.47
Fencing	.34	.49	.21	.24
Property tax	.14	.09	.08	.08
Total overhead cost	2.92	3.08	1.19	1.45
Total cost (operating & overhead) ^b	57.07	49.78	45.36	46.28
Plus purchases ^c	93.51	88.06	86.77	87.12
Total cost	150.58	137.84	132.13	133.40
Cost per lb. beef added, \$/cwt. ^b	50.01	32.31	23.49	24.93

^aIncludes labor for permanent pasture, temporary grazing, buildings, and fencing.

^bExcludes purchases and land charge for permanent pasture and woodland grazing.

^cValue of calves transferred from cow-calf operation, plus any bought.

Calves that were valued at \$24.89 per hundredweight before feeding were sold as fed calves at \$23.68 per hundredweight. Even when labor and land costs were deducted small operators lost \$23.54 per calf and medium operators \$10.04 and large operators made only \$1.59 per calf for their labor.

Economies associated with size were

⁵ Almost \$10 per acre of the temporary grazing costs was interest on land. Therefore, depending upon alternative uses of this land, returns may be viewed as somewhat higher.

much more evident in the holding operations. As a number of calves held per farm increased, total cost per calf decreased. But not only were producers with large herds the only group to recover total costs, they were also the only ones to fully recover operating costs.⁵ Producers with large herds added almost twice as much beef per calf as did those with small herds. When all costs were considered, cost per hundredweight added for large herds was \$26.52 lower than for small herds and \$8.82 less per hundredweight than for medium herds.

Table 16. Returns from holding beef calves past weaning weight, 46 producers, by herd size, Brown Loam Area, Mississippi, 1966-67.

Item	Herd size			Average all sizes
	Small	Medium	Large	
Number of farms	6	12	28	—
Average number calves held	21.8	30.8	101.5	72.7
Lbs. added per calf	114.1	154.0	193.1	185.6
Average total lbs., cwt.	24.88	47.43	196.08	134.97
Avg. price for beef added, \$/cwt.	22.93	23.86	24.68	23.68
	dollars			
Gross value added by holding ^a	667.67	1,117.49	4,643.47	3,205.06
Total credits per farm ^a	2,706.34	3,830.28	13,453.01	9,540.98
Costs:				
Operating	1,180.87	1,438.94	4,484.40	3,259.06
Overhead	63.48	94.80	120.24	105.96
Purchases ^b	2,038.67	2,712.79	8,809.54	6,335.92
Total costs per farm ^c	3,283.02	4,246.53	13,414.18	9,700.94
Returns above total cost: ^c				
Per farm	-576.68	-416.25	38.83	-159.96
Per calf held ^a	-26.45	-13.51	.38	-2.20
Returns above operating cost:				
Per farm	-513.20	-321.45	159.07	-54.00
Per calf held	-23.54	-10.04	1.57	-0.74
Returns above operating cost minus labor costs:				
Per farm	-330.08	-192.40	547.81	241.16
Per calf held	-15.14	-6.25	5.40	3.32

^aIncludes cash from sales and value of those still on hand.^bPrimarily transfers from cow-calf operation.^cExcludes land charge for permanent pasture and woodland grazing.^dGross value added minus operating costs.

APPENDIX

In estimating the costs of production both primary and secondary sources of data were used. Basic data were secured by personal interviews with farmers in the Brown Loam Area of Mississippi. Other sources of information included were Mississippi Agricultural Experiment Station bulletins and United States Department of Agriculture publications. In estimating the number of hours of labor used for repairing buildings and fences and in calculating the costs of silage, agricultural economists from the Mississippi Agricultural Experiment Station were consulted. All costs of materials were estimated at the 1966-67 price level, and wages were set at the minimum wage level. Rates for machinery

operation may be found in Appendix Table 1, along with the labor requirements for each operation. Fertilizer and seed costs are listed in Appendix Table 2.

In cases where the farmer produced the feed used in his operation, an estimated market value was used rather than production costs. This procedure was followed throughout the other phases of the operation.

In cases where the farmer kept calves on feed past weaning weight, the percentage use for that purpose of any building, equipment, labor, land, or material was reported and separated from the costs of the cow-calf operation. The value of any calves held past weaning was

Appendix Table 1. Tractor, fuel, and implement cost per acre, Brown Loam Area, Mississippi 1966^a

Item	Type	Hours per acre	Costs			Total
			Implement	Tractor	Fuel ^b	
Ammonia applicator	2R	.31	\$.79	\$.21	\$.18	\$1.18
Ammonia applicator	4R	.25	.20	.23	.19	.62
Breaking plow	2R	1.00	.67	.67	.57	1.91
Breaking plow	4R	.67	.67	.56	.62	1.85
Combine (self-propelled)	—	.42	6.45	—	.34	6.79
Cultipacker	2R	.34	.27	.23	.14	.64
Cultivator	2R	.50	.17	.36	.26	.79
Cultivator	4R	.24	.18	.20	.23	.61
Disc	2R	.63	.71	.42	.33	1.46
Disc	4R	.36	.48	.30	.38	1.16
Fertilizer distributor	10 ft.	.25	.25	.22	.11	.58
Fertilizer distributor	2R	.59	.17	.44	.26	.87
Forage harvester	PTO	.50	9.67	1.33	1.42	12.42
Grain drill	10 ft.	.38	.67	.26	.19	1.12
Harrow	2R	.31	.14	.21	.13	.48
Harrow	4R	.21	.13	.14	.12	.39
Middle breaker	2R	.59	.56	.39	.30	1.25
Middle breaker	4R	.30	.33	.40	.29	1.02
Mower (rotary)	—	.43	.32	.29	.19	.80
Mower (sickle)	—	.50	.73	.33	.22	1.28
Planter	2R	.56	.60	.37	.23	1.20
Planter	4R	.25	.41	.21	.17	.79
Sprayer	—	.22	.12	.14	.09	.35
Subsoiler (1-chisel)	—	.83	.47	.56	.62	1.65
Other ^c						

^aBased on tractor and equipment costs as reported by Tramel, Thomas E., and James T. Long, Power and Equipment costs in the Brown Loam Area of Mississippi, Mississippi State University, Agricultural experiment Station Bulletin 688, May 1964.

^bFuel @ \$0.285 per gallon.

^c Automobile (per mile)	\$.09
Truck, ½ to 1 ton (per mile)	.09
Truck, 1½ to 2½ ton (per mile)	.15
Trailer, 2-wheel (per hour)	.18
Trailer, 4-wheel (per hour)	.37
Tractor, 2-row (per hour) \$0.66 plus \$0.75 fuel cost	1.41
Tractor, 4-row (per hour) \$0.82 plus \$1.34 fuel cost	2.16

credited to the cow-calf operation and charged against this holding operation.

The straight-line method was employed in depreciating all buildings used by the beef enterprise. Farmers reported the estimated replacement cost, the total years of useful life, the average annual costs for repairs, and the percent use for the feed enterprise of each building. The annual building cost consisted of the yearly depreciation charge, the annual repair cost, plus an interest charge of 3 percent of the estimated replacement cost (equivalent to 6 percent of the half-life of the building). No attempt was made to

measure the percent age of the building.

An investment charge was made against the breeding herd by multiplying the average herd value by a 6 percent interest rate. The average herd value was computed by adding the values of the beginning and ending inventories and dividing by two. The breeding herd consisted of all brood cows, bulls, and replacement heifers; no charge was made for calves.

The farmer was asked to estimate the number of man-hours of labor which he used for feeding, daily chores, castration, vaccination, marketing, and

Appendix Table 2. Prices paid for fertilizer and seed, Brown Loam Area, Mississippi, 1966.^a

Item	Unit	Cost
Fertilizers:		
Lime	ton	7.25
Slag	ton	20.00
Ammonium nitrate	ton	72.50
Anhydrous ammonia	ton	105.00
Nitrate of soda	ton	59.50
Super phosphate 20%	ton	36.00
Potash 60%	ton	58.00
15-10-10	ton	72.00
13-13-13	ton	70.50
12-12-12	ton	66.00
12-8-8	ton	63.00
10-10-10	ton	65.00
10-20-10	ton	74.00
9-12-12	ton	58.00
8-8-8	ton	53.00
7-28-14	ton	75.00
6-24-24	ton	79.50
6-12-12	ton	62.00
6-8-8	ton	43.00
0-20-20	ton	58.00
Seeds:		
Soybeans	bu.	4.03
Wheat	bu.	3.00
Rye	bu.	4.00
Oats	bu.	1.50
Corn	bu.	13.00
Sorghum	lb.	.22
Bermuda	lb.	.78
Wespedeza	lb.	.24
White Clover	lb.	.84
Crimson clover	lb.	.31
Dallis	lb.	2.00
Lindsey 77	lb.	.22
Fescue	lb.	.20
Bahaia	lb.	.30
Wild winter peas	lb.	.11
Sudex	lb.	.18

^aThese prices are based on USDA and Mississippi Federated Cooperative reports.

similar activities. Estimates of labor used for all other jobs on the farm such as fencing, feed production, pasture work, and repairs were obtained from secondary sources. Although all farmers are not required to pay the minimum wage, it is the competitive price for labor. Monthly labor requirements for operations of different size are contained in Appendix Tables 4 and 5.

The cost of feed was estimated by the actual quantities of each feed stuff fed and its respective price as reported by the farmer. In each case the farmer reported the kind of feed, quantity used, and the

market value of the feed at the time used. The market value was used in each case whether the feed was home grown or purchased. The only exception was the cost of silage where production and harvesting costs were calculated from information supplied by the farmer and from secondary sources. This cost included charges for all materials, equipment, labor, and land used in the production and harvesting of the silage. Feed storage costs were included in the building costs. Custom rates for feed grinding and mixing were charged when reported by the farmer. In cases where

Appendix Table 3. Proportion of respondents receiving ASC payments for pasture improvements, and average amount of payment per participating farm, by County, by size of operation, Brown Loam Area, Mississippi, 1966-67

County	Size		
	: Small	: Medium	: Large
	----- Proportion receiving payment -----		
		(percent)	
Benton	36	57	67
Claiborne	100	71	88
Grenada	60	40	13
Holmes	44	67	90
Madison	100	100	100
Marshall	50	56	89
Tate	100	100	100
Wilkinson	100	88	100
Yazoo	100	83	83
	----- Payment per farm -----		
		(dollars)	
Benton	178.53	281.31	257.30
Claiborne	104.51	173.42	458.67
Grenada	117.93	133.03	255.75
Holmes	67.23	130.93	618.34
Madison	109.04	230.26	464.32
Marshall	184.82	292.19	320.00
Tate	99.14	209.86	773.33
Wilkinson	162.75	248.66	569.93
Yazoo	132.97	215.15	947.75

Source: These figures were obtained from the ASC office in each county listed. Although these are averages of actual amounts received by the respective farmers, they reflect only partially the funds available for each farmer. In each county there are a different criteria by which funds available to each farmer are calculated.

the farmer reported the use of self-owned and operated feed mills, the cost was estimated by the following method used for specialized equipment.

Additional equipment which was used primarily for the beef enterprise but not for pasture maintenance, forage harvesting, or feed processing was reported by the farmer. Items included in this category were cattle trailers, catch pens and chutes, feed troughs, self-feeders, and other such items. Costs for these items were calculated in the same manner as were building costs using straight-line depreciation, repair costs, and an interest charge of 3 percent. Again these costs were prorated to the cattle enterprise on a percentage use basis.

Farmers were asked to describe the practices which they used in the annual maintenance and re-establishment of their permanent pastures and to report the

number of acres on which these practices were applied. Any materials used were also reported. Costs were then determined by multiplying the quantity of each input or practice by its respective unit cost as listed in the appendix. If hay or seed were saved from the permanent pasture, the net value of each was calculated as the market value less a charge of \$0.30 per bale of hay (for cutting, raking, baling, and hauling) and \$6.79 per acre for seed combining.

The costs of providing temporary grazing on land other than permanent pasture were handled in the same manner as were the costs for permanent pasture with the exception of an added land charge of \$18.00 per acre. It was assumed that land which could be planted in temporary grazing could also be cultivated in crops. The land charge of 6 percent, with the land being valued at

Appendix Table 4. Average per farm monthly man-hour labor requirements of beef enterprise for feeding and daily chores and other jobs, 215 cow-calf operations by size, Brown Loam Area, Mississippi, 1966-67.

Size	: J	: F	: M	: A	: M	: J	: J	: J	: A	: S	: O	: N	: D	: Total
	(man-hours)													
<u>Small</u>														
Feeding and daily chores	58	55	53	24	22	22	22	22	21	22	30	50		401
Other ^a	4	3	5	6	7	7	6	5	5	6	4	3		61
Total	62	58	58	30	29	29	28	27	26	28	34	53		462
<u>Medium</u>														
Feeding and daily chores	92	87	83	31	27	26	27	27	26	29	43	80		578
Other ^a	3	3	7	14	11	8	10	9	10	10	7	4		96
Total	95	90	90	45	38	34	37	36	36	39	50	84		674
<u>Large</u>														
Feeding and daily chores	170	163	150	59	51	48	45	43	45	47	70	141		1,032
Other ^a	4	8	10	28	23	17	13	13	22	26	9	5		178
Total	174	171	160	87	74	65	58	56	67	73	79	146		1,210

^aIncludes castration, vaccination, branding.

Appendix Table 5. Average per farm monthly man-hour labor requirements of beef enterprise for feeding, daily chores and other jobs, 46 holding operations by size, Brown Loam Area Mississippi, 1966-67.

Size	: J	: F	: M	: A	: M	: J	: J	: J	: A	: S	: O	: N	: D	: Total
	(man-hours)													
<u>Small</u>														
Feeding and daily chores	19	19	19	10	5	5	5	5	5	5	14	19		130
Other ^a	0	1	0	0	0	0	0	0	0	0	0	0		1
Total	19	20	19	10	5	5	5	5	5	5	14	19		131
<u>Medium</u>														
Feeding and daily chores	20	19	15	4	0	0	0	0	0	0	4	19		81
Other ^a	0	1	0	0	0	0	0	0	0	0	0	0		1
Total	20	20	15	4	0	0	0	0	0	0	4	19		82
<u>Large</u>														
Feeding and daily chores	45	44	29	7	1	1	2	2	1	7	19	39		197
Other ^a	3	2	2	0	0	0	0	0	0	1	2	1		11
Total	48	46	31	7	1	1	2	2	1	8	21	40		208

^aIncludes castration, vaccination, branding.

Appendix Table 6. Acreage of pasture and estimated value per acre, 215 producers, by size of herd by subarea, Brown Loam Area, Mississippi, 1966-67.

	Area			Average
Size and item	North	Central	South	all areas
<u>Permanent pasture (Acres)</u>				
Small	135.1	104.0	105.0	118.4
Medium	230.8	213.7	220.6	220.9
Large	555.0	481.5	624.9	534.3
<u>Woodland pasture (Acres)</u>				
Small	48.3	101.2	159.9	84.3
Medium	119.4	101.9	146.1	117.2
Large	268.5	273.4	629.4	345.9
<u>Market value of permanent pasture (\$/A)</u>				
Small	199.48	191.35	123.13	186.43
Medium	225.00	219.65	157.81	208.24
Large	200.63	226.62	137.50	200.00
<u>Value of woodland pasture for grazing (\$/A)</u>				
Small	0.57	0.65	0.38	0.58
Medium	0.82	1.10	1.41	1.07
Large	0.92	1.18	1.84	1.24

\$300 per acre, was placed on this acreage. No attempt was made to adjust these costs for the possibility of using the same land for other enterprises.

Producers either estimated the replacement cost per mile or described the materials used and construction method of their particular fences. They were also asked the miles of fence on this farm and the annual repair cost per mile. The annual costs per mile of fence were then calculated by depreciating at a rate of 5 percent (allowing a 20-year life) plus the annual repair cost. This figure multiplied by the number of miles of fence on the farm yielded the total annual fencing cost.

The costs of yardage, insurance, and commissions at the sale barn were charged against the operation as reported by the cattlemen.

Vehicles used for hauling or transportation in connection with the cattle operation were charged at the following rates; automobiles, \$0.09 per mile; $\frac{1}{2}$ to 1 ton trucks, \$0.09 per mile; and 1 $\frac{1}{2}$ to 2 $\frac{1}{2}$ ton trucks, \$0.15 per mile. Any custom hauling was charged

exactly as reported. Tractors used for hauling and additional power requirements were charged at the rate of \$0.66 per hour for two-row models and \$0.82 per hour for four-row models plus the fuel cost.

The farmer reported expenses which were incurred for the health of animals. These costs included veterinarian fees, medication bills, and costs of insecticides. Electricity and other miscellaneous costs associated solely with the cattle enterprise were charged as reported.

Because of the wide variations in the value of pasture land, no charge was made for land except in the case of silage and temporary grazing.

Property tax was charged at a rate of \$0.32 per acre (the average of rates reported by tax assessors in the study counties) for open permanent pasture land.

The value of animals killed for beef were credited to the operation at the weight and value per pound reported by the farmer. If the animal had been held past weaning with other calves, the value was credited to the holding operation.

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Runoff and Sediment Production From North Mississippi Loessial Soils

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Contribution from the USDA Sedimentation Laboratory, Southern Branch, Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the Mississippi Agricultural Experiment Station and the University of Mississippi.

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RUNOFF AND SEDIMENT PRODUCTION FROM NORTH MISSISSIPPI LOESSIAL SOILS¹

By

KEITH C. MCGREGOR, JACKIE D. GREER, G. EDWARD GURLEY,
AND GERALD C. BOLTON²

INTRODUCTION

In general, the Brown Loam soils at the North Mississippi Branch Experiment Station are representative of the loess soils of the Southeastern United States. These soils have high silt and low sand contents, are moderately to relatively high in fertility, and are underlain by a Coastal Plain material of high sand content.

Large gullies and sediment-filled streams indicate the excessive erosion of Brown Loam soils in North Mississippi. The early development of cotton as a major cash crop enhanced the erosion process. In recent years, clean-tilled soybeans planted on irregularly shaped topography without regard to the contour have caused serious conservation problems.

Erosion problems with cultivated land led to a need for information on the relative erodibility of Brown Loam soil under different cover conditions and for cropping and management practices that would retard runoff and erosion. Quantitative erosion values were needed for use in equations for predicting erosion from specific areas with various conservation practices and soil-cover complexes. Practices that would restrict erosion to within acceptable tolerance limits could then be recommended to farmers.

These research needs led to studies by the Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the North Mississippi Branch

Experiment Station at Holly Springs, Mississippi. This bulletin reports the significant findings of these studies and summarizes the runoff and erosion data obtained from small plots and watersheds during a 7-year period. Detailed tabulations of the data are given in the Appendix.

Specific objectives of these studies included the following:

1. To evaluate the effect of contour cultivation on runoff and erosion.
2. To evaluate the effect of percent slope on runoff and erosion.
3. To determine the effects of ground cover and cropping management levels on runoff and erosion.
4. To determine the inherent erodibility of the Brown Loam soils.

¹A contribution from the USDA Sedimentation Laboratory, Southern Branch, Soil and Water Conservation Research Division, Agricultural Research Service, U. S. Department of Agriculture, in cooperation with the Mississippi Agricultural Experiment Station and the University of Mississippi.

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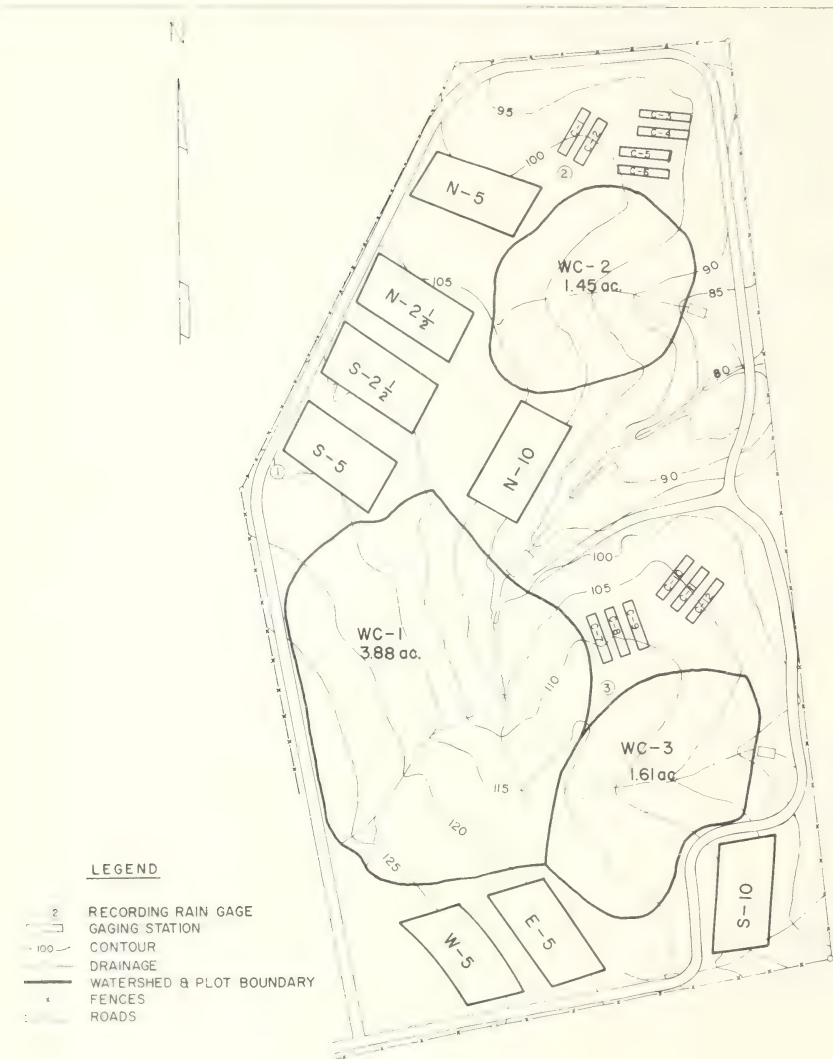


Figure 1
 LAYOUT OF PLOTS & SMALL WATERSHEDS
 NORTH MISSISSIPPI BRANCH EXPERIMENT STATION
 HOLLY SPRINGS, MISSISSIPPI
 U.S. DEPARTMENT OF AGRICULTURE
 AGRICULTURAL RESEARCH SERVICE
 OXFORD, MISSISSIPPI

DECEMBER 1966

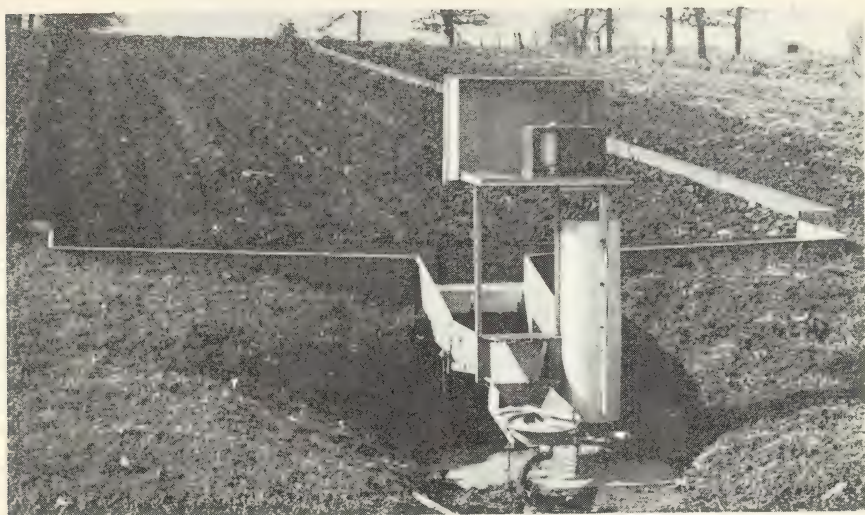


Figure 2 - Plot instrumentation included H-flume, water level recorder and Coshocton-type wheel sampler.

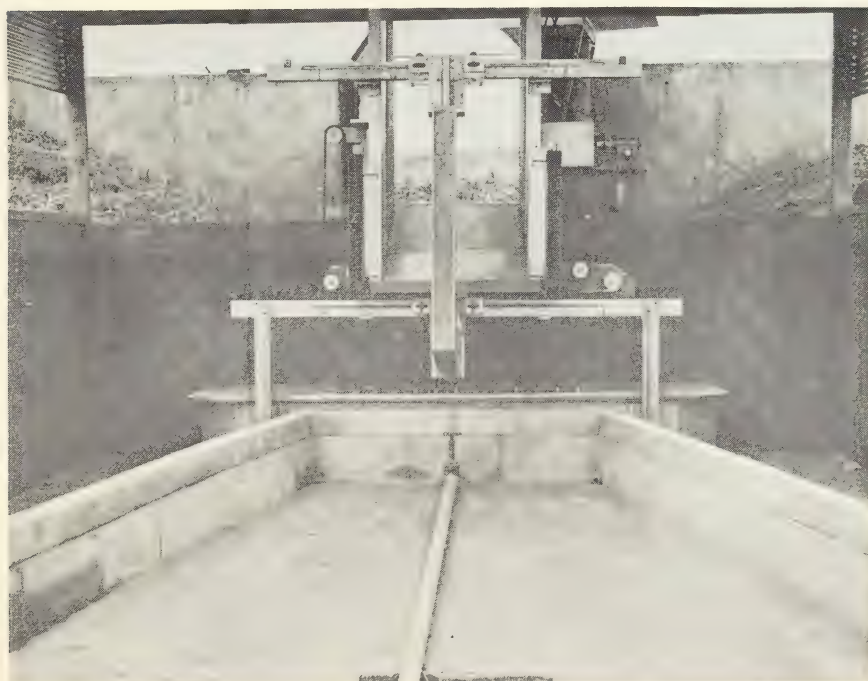


Figure 3 - Watershed instrumentation included an experimental battery-power traveling slot sampler.

PLOT DESCRIPTION AND EQUIPMENT

Figure 1 shows the layout of the experimental plots. Appendix table 1 gives the acreage, slope, soil type, and cropping practice for each area. Descriptions of the predominant soil types, Loring and Lexington silty clay loams, are given in Appendix table 2.

The equipment (**figure 2**) used for measuring runoff and soil loss for each of the small runoff plots included a 0.5- or 1.0-foot H-flume, an FW-1 water level recorder, an N-1 or N-2 Coshocton-type wheel sampler, a silt collection apron, and a runoff sample storage tank. The two fallow plots also had water-filled sediment traps located at the entrance to the flume to eliminate soil deposition within the flume. One of the fallow plots was equipped with a total-load runoff sampling device for collecting instantaneous samples of runoff at frequent intervals

during selected runoff events.

The equipment used for measuring runoff and soil loss for two of the small watersheds included a silt collection apron, a modified Parshall flume, an FW-1 water level recorder, a large silt collection pit, and an Iowa slot sampler. An experimental, battery-powered, traveling slot sampler (**figure 3**) was used on the third watershed (WC-3).

Data Processing

An automatic data processing program was used to compute runoff and soil loss rates and amounts. Field data were converted from chart to digital form with a decimal converter system (decimal converter, chart-reader, and card punch). Output data were from an electronic computer. A sample of printout data is presented in Appendix table 3.

PRECIPITATION

Figure 4 shows 49 years (1920-1968) of annual rainfall at the North Mississippi Branch Experiment Station. The 49-year average rainfall was 53 inches which is slightly higher than the 48 and 50 inches for the 1963-1968 and 1962-1968 water years, respectively, included in these studies. A water year is October 1 through September 30. Appendix table 4 shows how the monthly averages for the research period compare with the long-

time averages. The rainfall and erosion index values according to crop management periods are presented in Appendix table 5. Erosion index is a measure of the erosive potential of rainfall and is a function of rainfall energy and intensity.³

³Wischmeier, W. H. and Smith D. D. Predicting Rainfall Erosion Losses from Cropland East of the Rocky Mountains. USDA, Agriculture Handbook 282, 1965

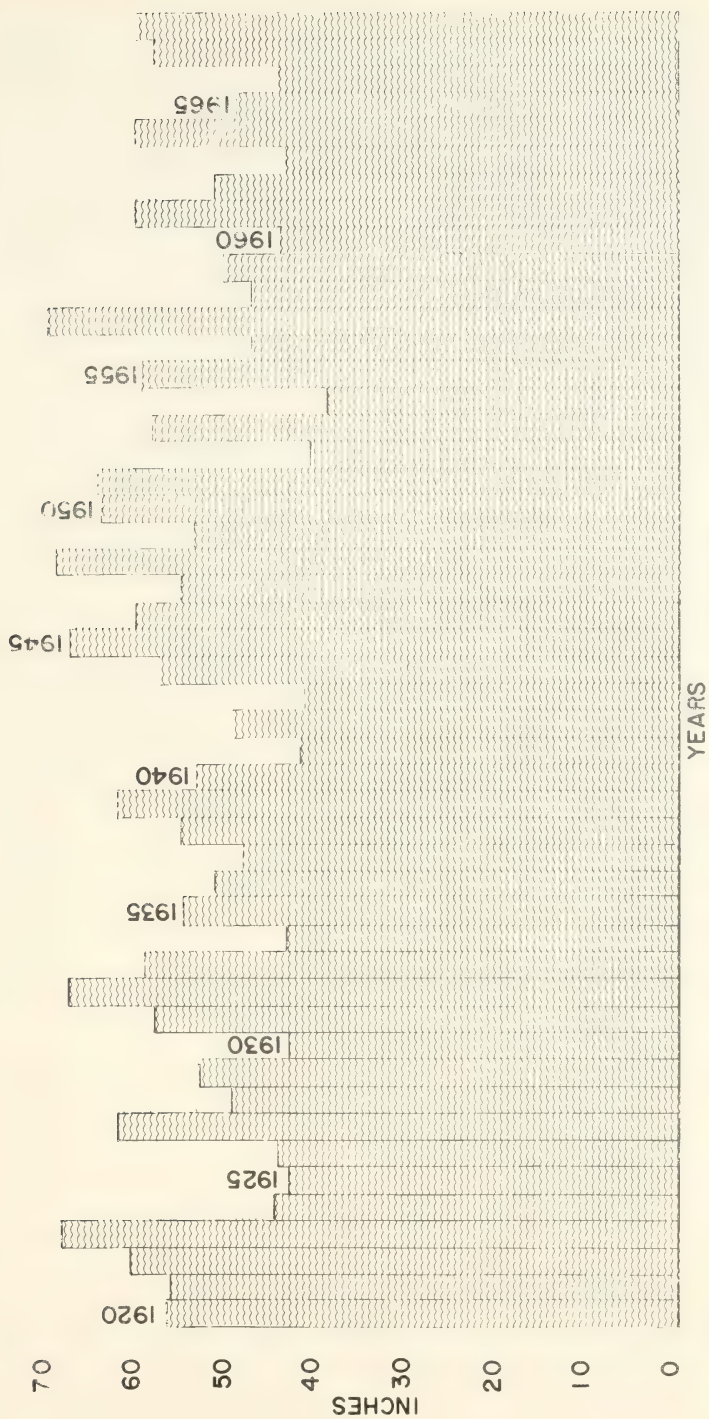


FIGURE 4 -- Annual precipitation for the North Mississippi Experiment Station.

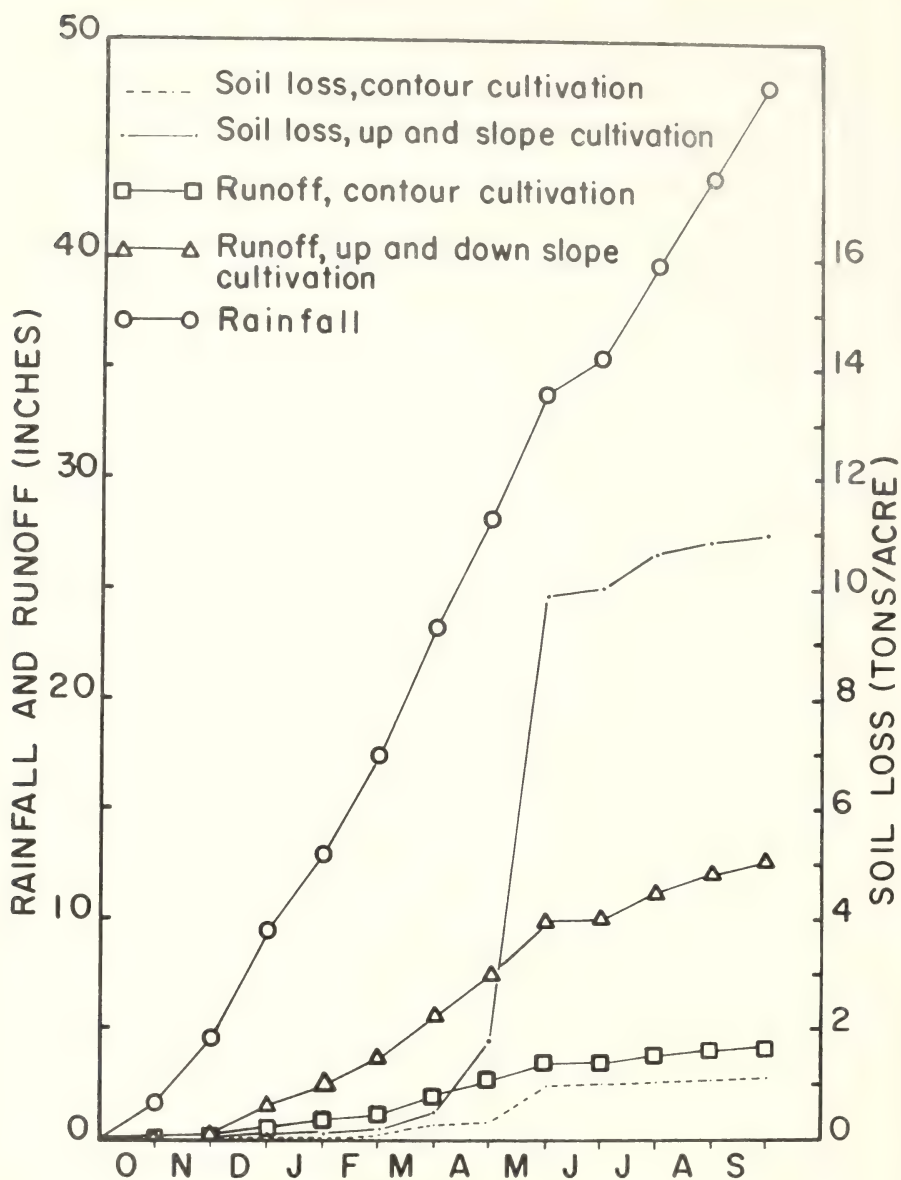


Figure 5 --Average monthly accumulation of rainfall, runoff and soil loss from 0.022-acre cultivated corn plots with 5 percent slope (Oct. 1962 - Sept. 1968)

CONTOURING VS. UP-AND-DOWN TILLAGE

Indirect and direct comparisons of up-and-down tillage versus contouring were made. Because of small plot dimensions, the direct comparison was an extreme or magnified example. The indirect comparison more realistically approached field conditions.

Direct Comparisons

Up-and-down corn rows on 0.022-acre, 5-percent sloping plots yielded a 6-year average of 13 inches of runoff and 11 tons per acre of soil loss. Contoured rows on similar plots yielded a 6-year average of only 4 inches of runoff and only 1 ton per acre of soil loss. **Figure 5** shows the 6-year average monthly accumulated rainfall, runoff, and soil loss for these plots. Average runoff and soil loss amounts by crop management periods are presented in Appendix table 6.

Indirect Comparisons

Projections of the measured soil loss from the up-and-downhill percent sloping, 72.6-foot-long rows discussed above were compared with measured soil loss from 2.5, 4.25, and 10 percent sloping 0.25-acre plots with contoured graded rows and grass waterways (**figure 6**). Projections were based on a slope-effect

chart in Agriculture Handbook 282.³ The overland slope length of the contoured plots was 72.6 feet and row length was 150 feet. The soil loss from contoured graded rows compares with estimated soil loss from up-and-down rows as follows:

$$E_2 = 0.79 E_1(10) - 0.046S$$

Where E_2 = soil loss for graded contoured rows T/A/Y

E_1 = soil loss for up-and-downhill rows T/A/Y

S = land slope, percent

This relationship was derived by dividing the equation relating E_2 and S by the equation relating E_1 and S and solving for E_2 . These equations are shown in figure 6.

The ratio of E_2 to E_1 is 0.60 and 0.27 for 2.5 and 10 percent land slopes, respectively. Using the above formula, conservationists can estimate the reduction in soil loss with contoured graded rows and grass waterways where row grades and lengths are similar to those in this experiment. These estimations can then be weighed against the advantage up-and-downhill rows provide in accommodating large mechanical operations with less manual labor, time, and expense.

³Refers to literature cited p. 6

EFFECT OF PERCENT SLOPE ON RUNOFF AND EROSION

The relationship of slope, runoff, and soil loss from 0.25-acre corn plots with contoured graded rows, evaluated from 7 years of data, is shown graphically in **figure 7**. Row lengths were 150 feet and were graded 0.2 to 0.4 foot per hundred

feet to a grass waterway. Runoff and slope increases were directly proportional while soil loss and slope increases were nearly so. The annual runoff and soil loss values are presented in Appendix tables 7 and 8, respectively. Corn yields decreased

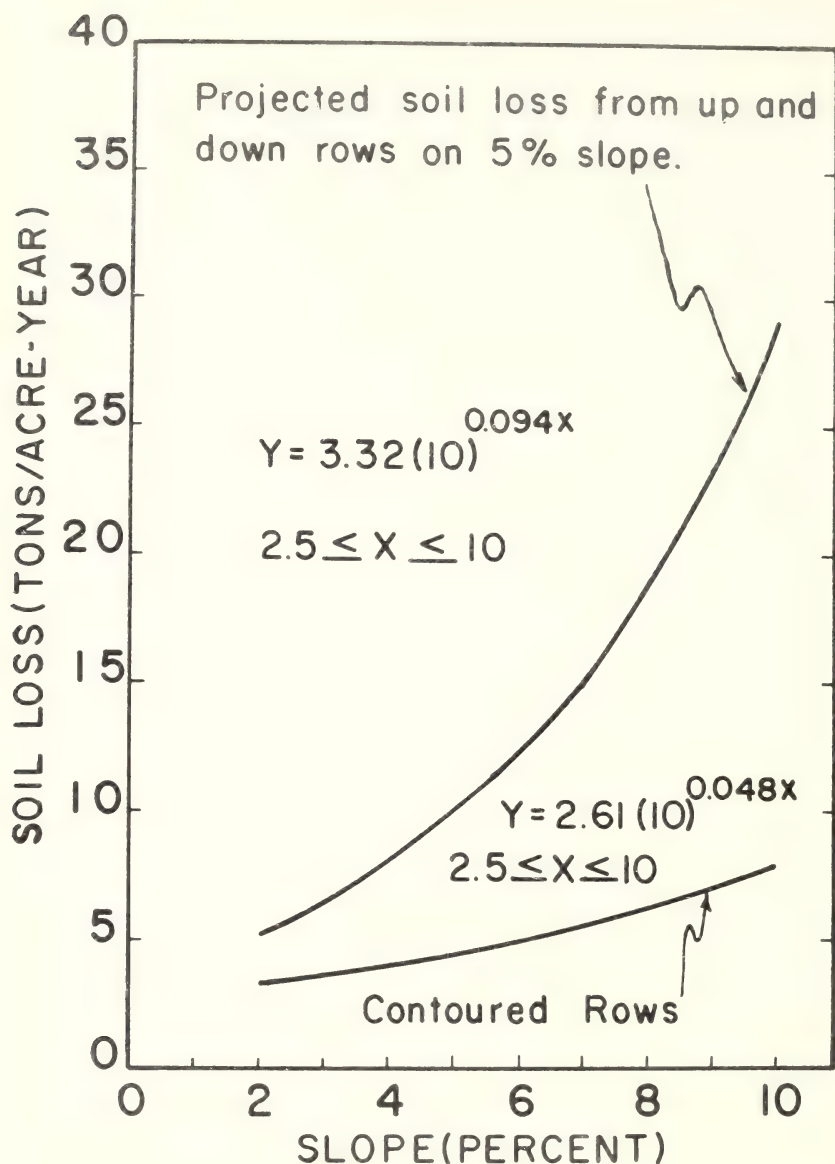


Figure 6 --Effect of slope on Soil Loss from graded contoured rows and from up and down rows. (10-1-62 through 9-30-68)

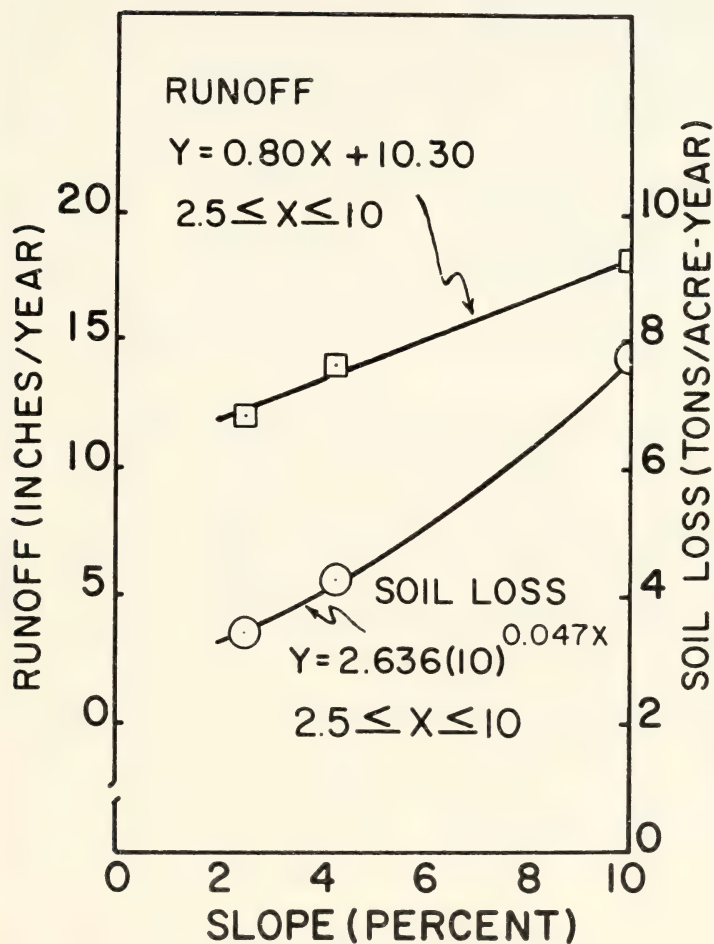


Figure 7 -- Effect of slope on Mean Annual Runoff and Soil Loss from 0.25-acre plots with contoured graded rows. (10-1-61 through 9-30-68) Mean Annual Rainfall was 49.76 inches.

with slope increases, possibly due to differences in moisture retention. The 7-year average corn yields were 59, 51, and 34 bushels per acre on 2.5, 4.25, and 10 percent slopes, respectively. The 7-year average residue amounts, estimated from residue samples, were 3.5, 3.7, and 3.1 tons per acre on 2.5, 4.25, and 10 percent slopes, respectively.

Appendix table 9 shows the percent of the 7-year annual rainfall, erosion index, runoff, and soil loss in the seedbed preparation, early growth, early growth to harvest, and residue management periods.

Only 14 percent of the annual rainfall and 14 percent of the annual erosion index occurred during the seedbed preparation and early growth periods; yet, the 2.5, 4.25, and 10 percent sloping plots yielded 52, 65, and 60 percent of their annual soil loss, respectively, during these periods. During the remainder of the year, the 2.5, 4.25, and 10 percent slopes had only 1.6, 1.5, and 3.1 tons per acre of soil loss, respectively. Based on records for the entire year, cultivation of corn is not recommended on slopes greater than 6 percent, even with contoured graded rows and grass waterways.

EFFECT OF SOD-BASED ROTATION ON RUNOFF AND EROSION

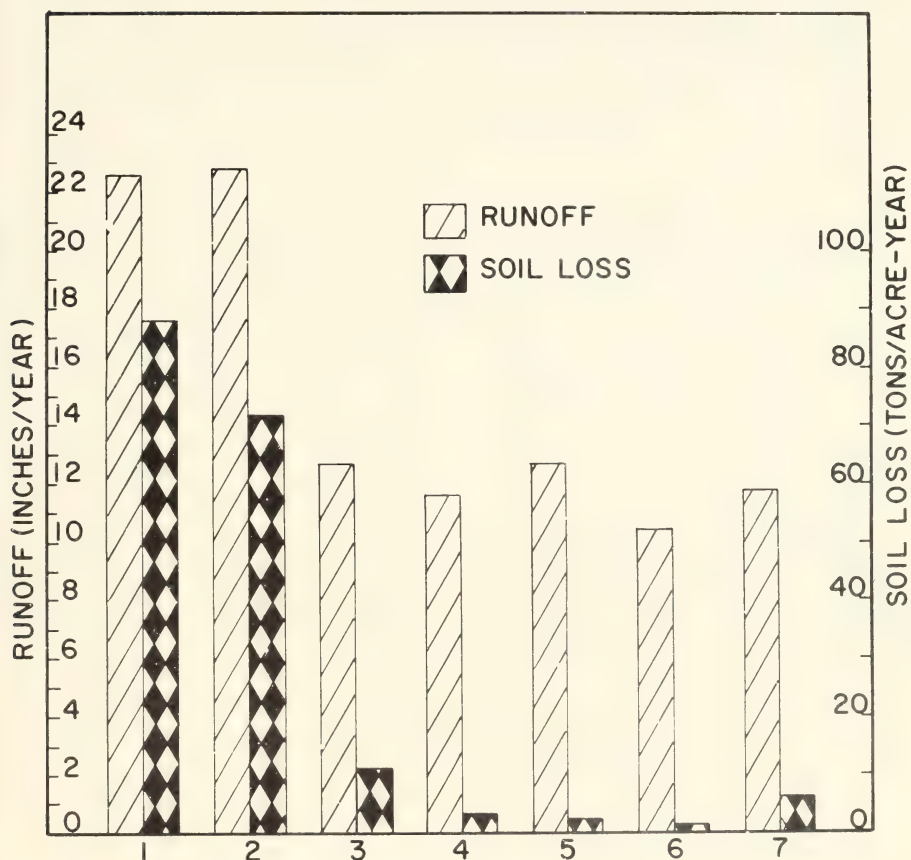
A sod-based rotation of two years of Coastal bermudagrass followed by one year of corn on 5-percent sloping 0.022-acre plots yielded an annual average soil loss of 3 tons per acre and 12 inches of runoff during the six-year period 1963-1968. There were no significant differences in runoff from first-year grass, second-year grass, corn after two years of grass, or continuous corn; but there were significant differences in soil loss (**figure 8**). The average runoff and soil loss by

management periods during the 6 years are presented in Appendix table 6. Annual runoff and soil loss values are presented in Appendix tables 7 and 8, respectively.

Yields from corn following grass exceeded those from continuous corn planted up-and-downhill in 4 of the 6 years (**table 1**). However, corn following grass frequently had to be replanted by hand because of poor stands. Because of

Table 1.—Crop yields on 0.022-acre plots (5-percent slope)

	1st. yr. grass tons/acre	2nd. yr. grass tons/acre	up & downhill corn after grass bu./acre	continuous corn up & downhill bu./acre	corn after corn contour bu./acre
1963	1.25	1.92	69.00	57.00	79.50
1964	1.20	1.94	54.06	37.41	56.94
1965	0.92	1.12	60.09	53.13	65.85
1966	1.29	2.04	31.20	26.60	30.50
1967	1.38	2.75	84.80	96.40	101.40
1968	1.94	1.63	21.00	28.70	51.80
Avg.	1.33	1.90	53.36	49.87	64.33



1. Bare fallow (Loring)
2. Bare fallow (Lexington)
3. Continuous corn up and down slope
4. Rotation system
5. First year grass
6. Second year grass
7. Corn after two years grass

Figure 8 --Effect of cover on runoff and soil loss from 1/45-acre, 5-percent sloping plots. (10/1/62 through 9/30/68)

this fact, and because of the competition for moisture during dry seasons, the sod-based rotation system must be considered impractical for general farming purposes.

The system does show promise for the future with an improvement in planting techniques in combination with irrigation during dry seasons.

SMALL WATERSHEDS

The 1.61-acre, 6.5-percent average slope watershed was in a poor vs. improved management study before 1966.⁴ In 1966 a grass waterway was established and corn planted on contoured graded rows. The 1967 and 1968 average annual runoff and soil loss was 12 inches and 6 tons per acre, respectively. Approximately 43 percent of the total soil loss was during the month of May.

Figures 9 and 10¹ show the average monthly accumulated rainfall, runoff and soil loss during 3 years preceding and 5 years after terracing of a 1.45-acre,

7.0-percent average slope watershed cropped continuously in corn. The parallel terraces and grass waterway system reduced the average annual soil loss from 12 to 6 tons per acre-year. The dominant role of cover in providing erosion control is illustrated by the fact that more than 50 percent of the annual soil loss occurred during May and June both before and after terracing.

⁴Doty, C. W., and Dendy, F. E. Improved Management Reduces Soil and Water Losses. Mississippi Farm Research, Volume 25, No. 4, 1961.

GROSS EROSION OF BARE FALLOW PLOTS (LORING & LEXINGTON, SILTY CLAY LOAMS)

Two bare fallow plots were installed in September 1960. Each plot was 72.6 feet long, 13.3 feet wide, and had a slope of 5 percent. The plots were cultivated in the spring in the same manner as conventional row crops. They were disk harrowed and section harrowed at other times whenever a surface crust formed, vegetation appeared, or conventional row crops were cultivated. Runoff and soil loss measurements were not taken until approximately two years after installation

of the plots to allow time for decomposition of prior crop residues.

Rainfall for the 6 years of record averaged 48 inches per year—5 inches below the long-time average. Soil losses were 88 and 71 tons per acre per year for Loring and Lexington silty clay loams, respectively. These rates are equivalent to the loss of approximately 0.5 and 0.4 inch of topsoil per year. Soil loss rates for short intervals during storms ranged as high as 182 tons per acre per hour.

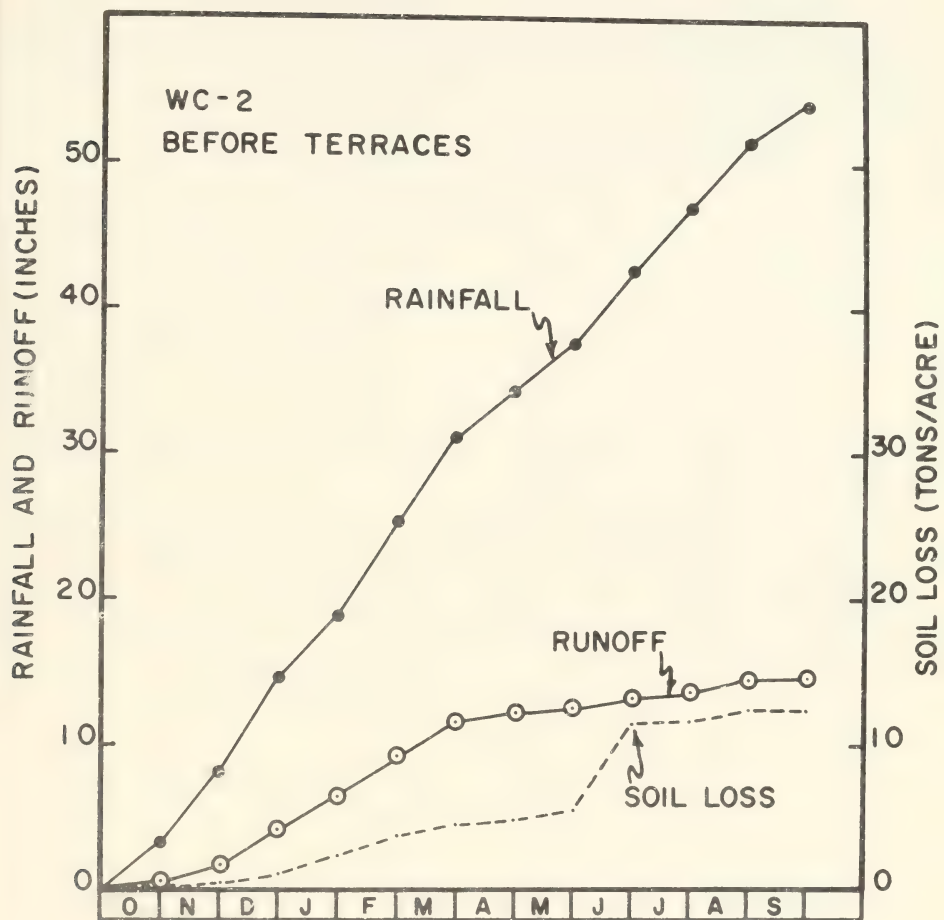


Figure 9.--Accumulated Rainfall Runoff and Soil Loss Before Terracing (3-Year Average, 1960-1962).

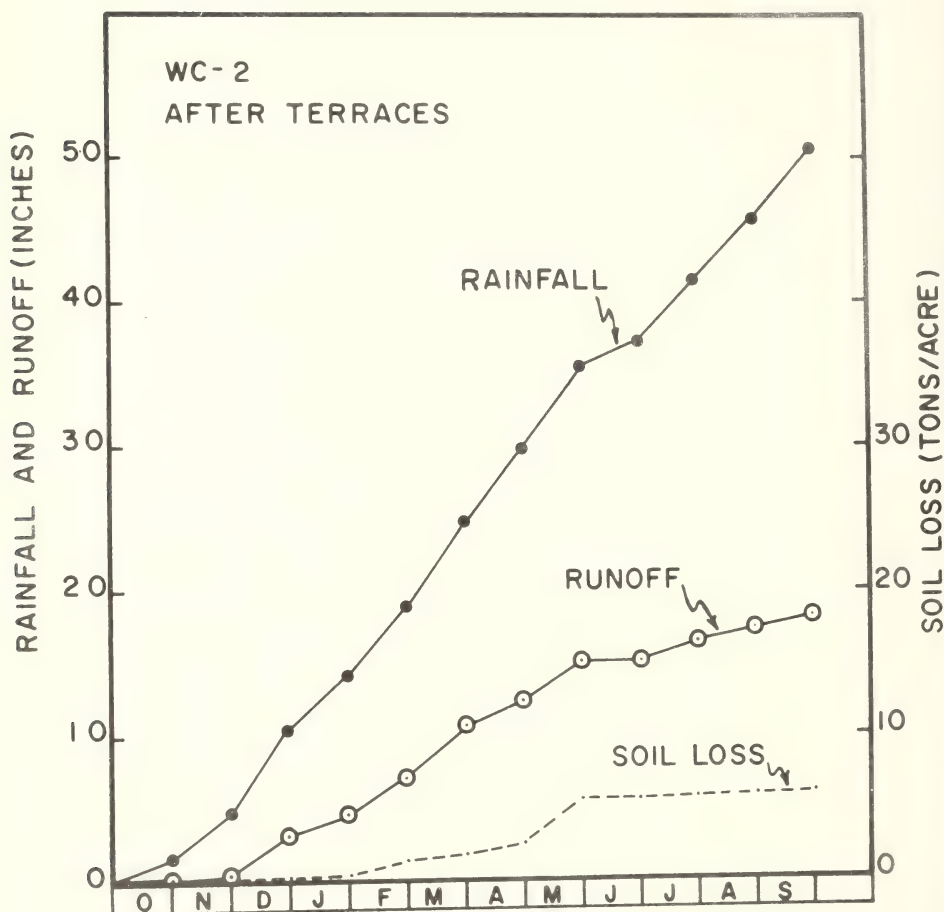


Figure 10.--Accumulated Rainfall, Runoff, and Soil Loss After Terracing (5-year Average, 1964-1968).

ERODIBILITY FACTORS FOR LORING AND LEXINGTON SILTY CLAY LOAMS

Soil erodibility factors are used extensively for predicting watershed sediment yields and field erosion rates. Although the erodibility factor (K) is only one of the six factors in the soil loss prediction equation, the accuracy of the K factor is very important in selecting the most practical farm conservation plan for a particular soil and in estimating sediment storage requirements of reservoirs.

The soil loss prediction equation derived by Wischmeier and Smith³ is:

$$A = RKLS\bar{C}P$$

where A is the average annual soil loss in tons per acre.

R, is the rainfall factor

K, is the soil-erodibility factor.

LS, is the length and steepness of slope factor.

C, is the cropping and management factor.

P, is the supporting conservation practice factor (terracing, strip-cropping, contouring).

The K factor is usually established from field research of standard plots. A standard plot is 72.6 feet long with a uniform slope of 9 percent in continuous fallow tilled up and down slope, plowed and placed in conventional seedbed condition each spring, and cultivated as needed to prevent vegetal growth or serious crusting. Under standard plot conditions, the LS, C, and P factors have a value of 1.0 and K equals A/R or A/EI. The bare fallow plots at Holly Springs were on 5 percent slopes; consequently, the K factors were calculated with the following formula:

$$K = \frac{\text{Sum of ASL}}{\text{Sum of EI}} \text{ or } K = \frac{\sum \text{ASL}}{\sum \text{EI}}$$

where K is the erodibility factor.

ASL is adjusted soil loss during each storm, or measured soil loss from a 5-percent slope divided by 0.45 (adjustment factor)³ to raise the soil loss to that expected from a 9-percent slope.

EI is erosion index of each storm or kinetic energy (E) of storm rainfall in hundreds of foot-tons per acre times the maximum 30-minute intensity (I) of storm rainfall in inches per hour.

A storm was defined as precipitation amounting to 0.5 inch or more occurring without a continuous break of six hours. Since measurements were sometimes made following two or more storms, the exact soil loss could not be determined for the individual storms; therefore, such storms were omitted from analyses.

The K values for Loring and Lexington silty clay loams, obtained by dividing the total 6-year adjusted soil loss from usable storms by the total 6-year EI of those same storms, were 0.49 and 0.40, respectively. The average erosion index (EI) distribution during the six years followed closely the long-time average as shown in figure 11. The K factors for each year are presented in table 2. The probable error of mean values are also given in table 2.

The adjusted soil loss and EI values for each storm are shown graphically in figures 12 and 13. Each dot on the graphs represents an individual storm K factor. Since the lines shown on the graphs were forced to go through the origin, they are not "lines of best fit". Equations of such lines are:

³Refers to literature in footnote 3.

Table 2.—Erodibility Factors by Water Years (Oct. 1 — Sept. 30)

Water Year	Adjusted Soil Loss Erosion Index	
	Loring	Lexington
1963	0.42	0.33
1964	0.49	0.40
1965	0.82	0.71
1966	0.41	0.43
1967	0.44	0.38
1968	0.43	0.24
Average	0.50	0.42
<u>Sum ASL (1963-1968)</u>	0.49	0.40
Sum EI		
Probable error of mean	$\pm .04$	$\pm .04$

(Loring) $ASL = 0.46 EI + 0.56$

and

(Lexington) $ASL = 0.36 EI + 0.58$

where $ASL = \text{adjusted soil loss}$

$[EI = \text{erosion index}]$

The coefficients of EI above may also be considered reliable estimates of K values for Loring and Lexington silty clay loams.

The fluctuation of soil loss with erosion index can be partly explained by the effects of cultivation. Cultivation in-

creased water infiltration capacity, thereby reducing runoff and delaying peak rates of runoff and soil loss. After the soil became saturated, uniform overland flow produced sheet erosion, but not at the rate that later occurred with the formation of zig-zagged rills that concentrated the runoff and slightly increased runoff travel distance. In several instances, soil losses during storms immediately following cultivation were less than those during smaller, lower intensity storms occurring at other times.

SUMMARY

Precipitation during the period of record was representative of the long-time average.

The ratio of soil loss from contoured rows with grass waterways to that from up-and-down rows decreased with increases in slope, ranging from 0.60 to 0.27 for 2.5 and 10 percent slopes, respectively.

Average annual runoff and soil loss from contoured 0.25-acre corn plots on 2.5, 4.25, and 10 percent slopes, were 12, 14, and 18 inches and 3, 4, and 8 tons per

acre, respectively. Most of the erosion occurred during the early growing season when the soil was essentially bare. Based on records for the entire year, cultivation of corn is not recommended on slopes greater than 6 percent, even with contoured graded rows and grass waterways.

Soil losses were 3 and 11 tons per acre per year and corn yields were 53 and 50 bushels per acre per year from a 3-year rotation of Coastal bermudagrass 2 years and corn and from continuous corn,

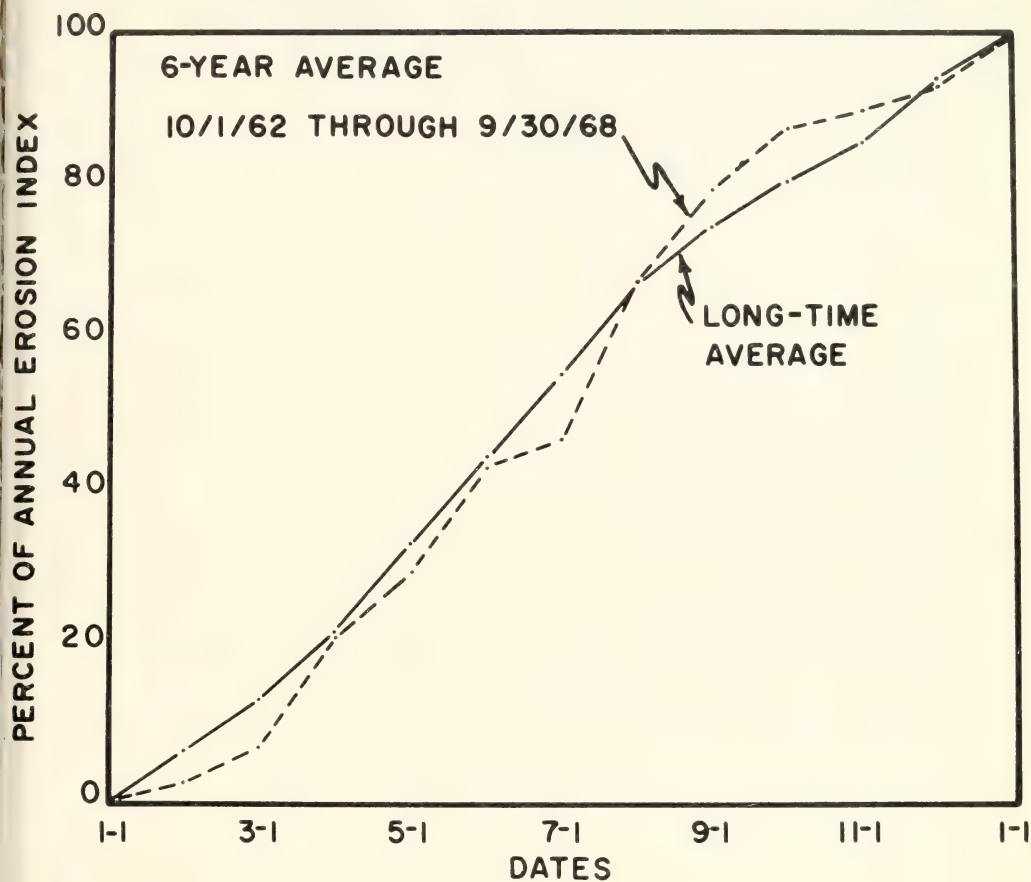


Figure 11.—Average Monthly Accumulated Erosion Index Distribution.

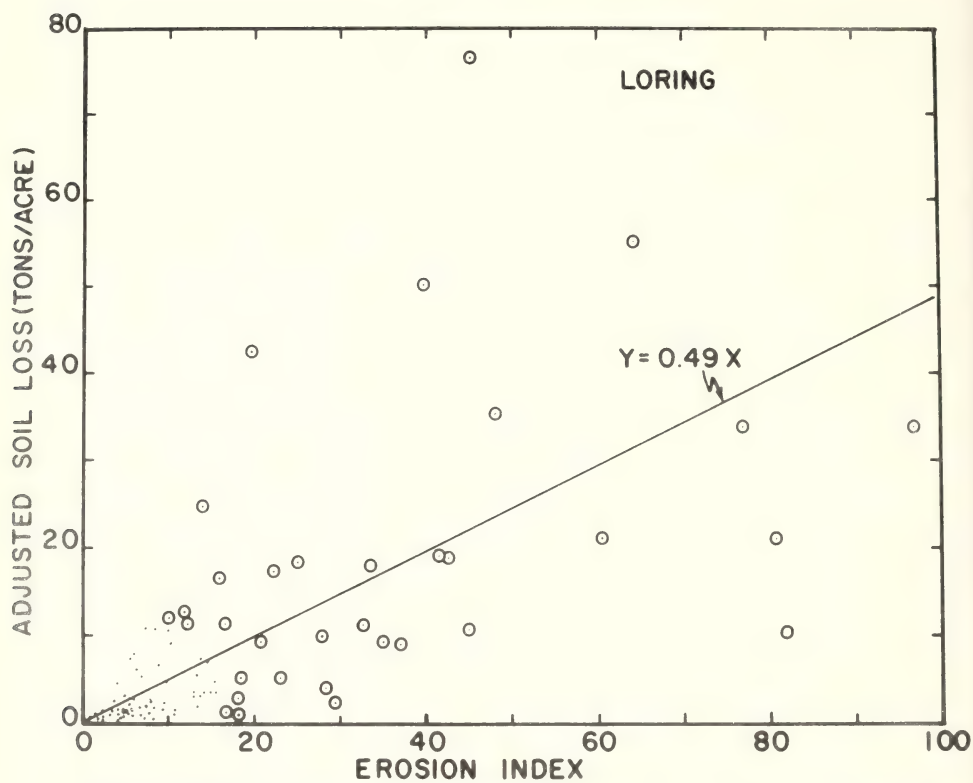


Figure 12.--Relationship Between Erosion Index and Soil Loss from Loring Silty Clay Loam Plot.

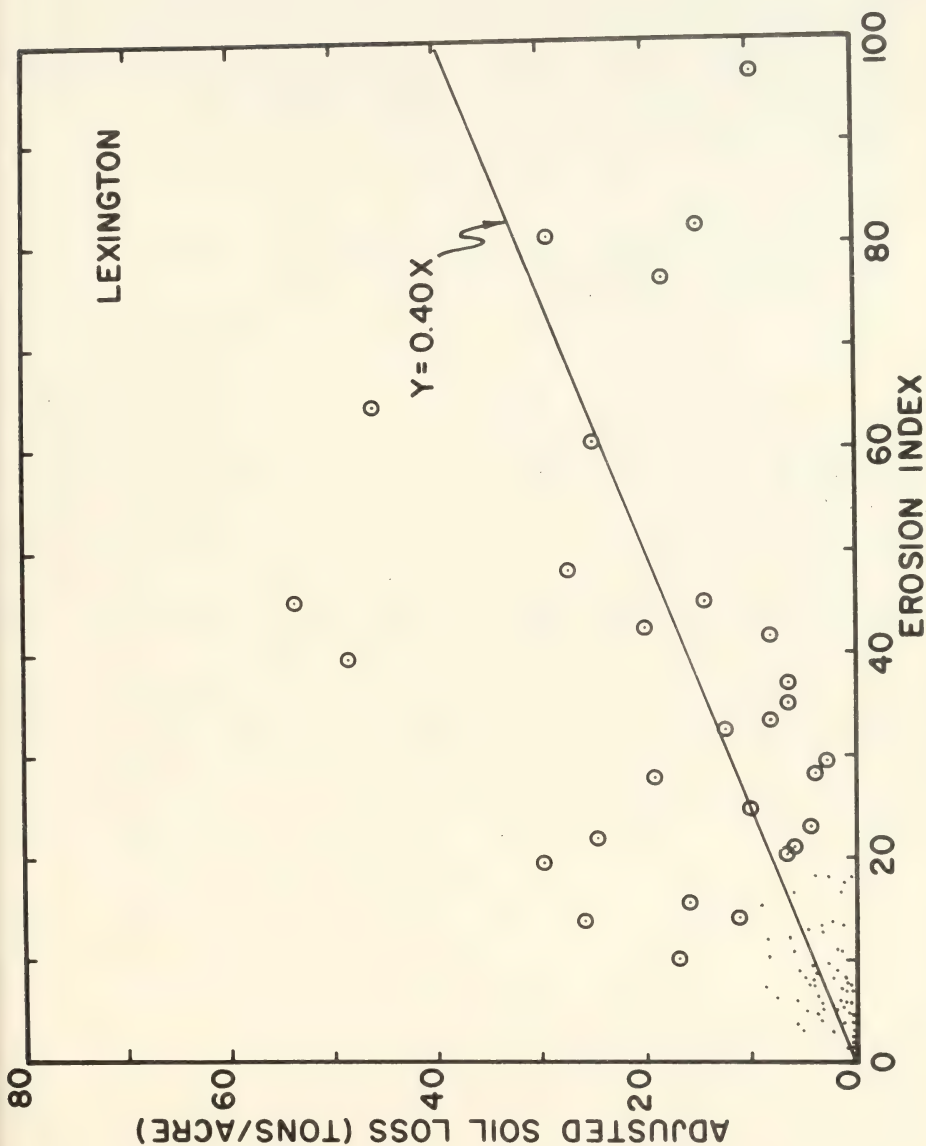


Figure 13.--Relationship Between Erosion Index and Soil Loss From Lexington Silty Clay loam Plot.

respectively. Corn stands were erratic in the rotation. This difficulty would have to be overcome before this conservation rotation could be considered practical.

Parallel terraces and a grass waterway on a 1.45-acre watershed with an average slope of 7 percent, cropped continuously in corn, reduced erosion by 50 percent,

from 12 to 6 tons per acre per year.

Erodibility factors for use in the soil loss prediction equation were 0.49 and 0.40 for Loring and Lexington silty clay loam, respectively. The soil loss from bare fallow plots on 5-percent slope averaged 80 tons per acre per year.

LIST OF APPENDIX TABLES

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Appendix Table 1. Soil type, slope, acreage and cropping practice for each area.

Area No.	Cropping Practice	Size Acres	Slope Percent	Soil Type	No. years of data
C-1	Sod-based rotation	0.022	5.00	Loring, silty clay loam	6
C-2	Continuous corn on contour	0.022	5.00	Loring, silt loam	6
C-3	Sod-based rotation	0.022	5.00	Lexington silt loam	6
C-4	Sod-based rotation	0.022	5.00	Loring, silt loam	6
C-5	Fallow plot	0.022	5.00	Loring, silty clay loam	6
C-6	Continuous corn up & down hill	0.022	5.00	Loring, silt loam	6
C-7	Fallow plot	0.022	5.00	Lexington, silty clay loam	6
C-8	Sod-based rotation	0.022	5.00	Loring, silty clay loam	6
C-9	Continuous corn up & down hill	0.022	5.00	Loring, silty clay loam	6
C-10	Continuous corn on contour	0.022	5.00	Loring, silty clay loam	6
C-11	Sod-based rotation	0.022	5.00	Loring, silt loam	6
C-12	Sod-based rotation	0.022	5.00	Loring, silt loam	6
S-2½	Continuous corn on contour	0.250	2.50	Memphis, silty clay loam	7
N-2½	Continuous corn on contour	0.250	2.50	Memphis, silt loam	7
S-5	Continuous corn on contour	0.250	4.25	Loring, silty clay loam	7
W-5	Continuous corn on contour	0.250	4.25	Loring, silt loam	7
S-10	Continuous corn on contour	0.250	10.00	Lexington, silty clay loam	7
N-10	Continuous corn on contour	0.250	10.00	Providence, silty clay loam	7
E-5	Continuous cotton	0.250	5.00	Loring, silt loam	2
N-5	Continuous cotton	0.250	5.00	Memphis, silty clay loam	2
WC-1	Corn-legume rotation	3.880	7.80	Lexington, Memphis, and Ruston	3
WC-2	Continuous corn (terraced)	1.450	7.00	Providence, Loring, and Memphis	5
WC-3	Continuous corn (contoured)	1.610	6.50	Lexington, Loring, and Memphis	2

Appendix Table 2. Soil Descriptions

Plow layer - upper 7 inches Type of clay	Loring silty clay loam	Lexington silty clay loam
	Kaolinite and Montmorillonite	Kaolinite and Montmorillonite
Clay content	28.0%	27.7%
Silt content	70.0%	69.8%
Sand content	02.0%	02.5%
Organic matter content	00.1%	00.2%
Suspension percentage	06.8%	10.2%
Surface		
Bulk density	1.55 gms./cc	1.48 gms./cc
pH	5.20 gms./cc	5.20 gms./cc
B Horizon	1.50 gms./cc	1.46 gms./cc

APPENDIX TABLE 3.--Sample of Printout Data

RUNOFF AND SEDIMENT COMPUTATIONS II					STATION									
W'SHD NO.	DATE			TIME	TIME INT. (MIN.)	R. O. RATE (IN./HR.)	R.O. RATE FOR INT. (IN./HR.)	R.O. FOR INT. (IN.)	ACC. R. O. (IN.)	S. L. RATE (T/A/HR)	ACC. S. L. (T/A)	C* E	EV. NO.	CARD NO.
	MO.	DA.	YR.											
62053	8	3	67	2330		0.0				0.0		0	113	1872
62053	8	3	67	2333	3	0.0304	0.015	0.001	0.001	0.042	0.001	0	113	1873
62053	8	3	67	2335	2	0.4227	0.227	0.008	0.008	0.581	0.011	0	113	1874
62053	8	3	67	2336	1	2.0755	1.249	0.021	0.029	2.850	0.040	0	113	1875
62053	8	3	67	2337	1	1.8015	1.938	0.032	0.061	2.474	0.084	0	113	1876
62053	8	3	67	2339	2	3.7589	2.780	0.093	0.154	5.162	0.212	0	113	1877
62053	8	3	67	2340	1	2.7429	3.251	0.054	0.208	3.767	0.286	0	113	1878
62053	8	3	67	2341	1	6.5939	4.668	0.078	0.286	9.056	0.393	0	113	1879
62053	8	3	67	2343	2	5.2036	5.899	0.197	0.483	7.146	0.663	0	113	1880
62053	8	3	67	2344	1	9.1120	7.158	0.119	0.602	12.514	0.827	4	113	1881
62053	8	3	67	2345	1	6.2468	7.679	0.128	0.730	8.579	1.003	0	113	1882
62053	8	3	67	2347	2	4.4788	5.363	0.179	0.909	6.151	1.248	0	113	1883
62053	8	3	67	2349	2	3.4285	3.954	0.132	1.041	4.708	1.429	0	113	1884
62053	8	3	67	2350	1	2.2532	2.841	0.047	1.088	3.094	1.494	0	113	1885
62053	8	3	67	2351	1	1.8637	2.058	0.034	1.122	2.559	1.541	0	113	1886
62053	8	3	67	2352	1	1.1777	1.521	0.025	1.148	1.617	1.576	0	113	1887
62053	8	3	67	2356	4	1.3589	1.268	0.085	1.232	1.866	1.692	0	113	1888
62053	8	3	67	2358	2	2.1191	1.739	0.058	1.290	2.910	1.772	0	113	1889
62053	8	3	67	2400	2	1.2418	1.680	0.056	1.346	1.705	1.849	0	113	1890
62053	8	3	67						1.346		1.849	1		1891
62053	8	4	67	5	5	0.7608	1.001	0.083	1.430	1.045	1.963	0	113	1892
62053	8	4	67	8	3	0.8241	0.792	0.040	1.469	1.132	2.018	0	113	1893
62053	8	4	67	10	2	0.5761	0.700	0.023	1.492	0.791	2.050	0	113	1894
62053	8	4	67	13	3	0.3182	0.447	0.022	1.515	0.437	2.080	0	113	1895
62053	8	4	67	17	4	0.1461	0.232	0.015	1.530	0.201	2.102	0	113	1896
62053	8	4	67	20	3	0.1162	0.131	0.007	1.537	0.160	2.111	0	113	1897
62053	8	4	67	23	3	0.0615	0.089	0.004	1.541	0.084	2.117	0	113	1898
62053	8	4	67	25	2	0.0458	0.054	0.002	1.543	0.063	2.119	0	113	1899
62053	8	4	67	27	2	0.0282	0.037	0.001	1.544	0.039	2.121	0	113	1900
62053	8	4	67	31	4	0.0219	0.025	0.002	1.546	0.030	2.123	0	113	1901
62053	8	4	67	50	19	0.0158	0.019	0.006	1.552	0.022	2.131	0	113	1902
62053	8	4	67	100	10	0.0	0.008	0.001	1.553	0.0	2.133	0	113	1903
62053	8	4	67						0.207		0.285	1		1904
62053	8	4	67		130				1.553		2.133	2	113	1905

* CODE: 1 - Daily Total; 2 - Event Total; 4 - Peak Discharge

Appendix Table 4.--Monthly Precipitation

	6-Year Average (1963-1968)* (inches)	7-Year Average (1962-1968)* (inches)	49-Year Average (1920-1968) (inches)
January	3.41	3.93	5.30
February	4.46	4.81	4.85
March	5.85	5.45	5.83
April	5.03	4.82	5.24
May	5.58	5.05	4.22
June	1.65	2.43	3.81
July	4.28	4.41	4.06
August	4.04	4.02	3.00
September	4.14	4.07	3.65
October	1.73	1.68	2.64
November	2.80	3.57	4.80
December	4.94	5.53	5.21
Total	47.91	49.77	52.61

*Water Years

Appendix Table 5.--Rainfall and erosion index by management periods

Water Year	Residue Management		Seedbed Preparation		Early Growth		Early Growth to Harvest		Total	
	Rainfall inches	EI	Rainfall inches	EI	Rainfall inches	EI	Rainfall inches	EI	Rainfall inches	EI
1962	38.16	239.88	1.03	4.56	.12	.11	21.58	248.19	60.89	492.74
1963	15.37	48.92	5.24	30.16	.67	2.05	13.84	169.78	35.12	250.91
1964	26.09	132.02	7.39	56.88	1.67	3.58	17.28	208.00	52.43	400.48
1965	41.30	312.81	.54	1.90	2.52	11.54	13.72	138.78	58.08	465.03
1966	17.45	94.60	1.42	14.27	9.37	83.06	8.91	72.12	37.15	264.05
1967	18.70	66.82	.06	.04	12.81	103.98	19.39	237.09	50.96	407.93
1968	31.11	161.10	.89	2.29	6.37	53.95	15.32	217.12	53.69	434.46
Average (7 yrs.)	26.88	150.88	2.37	15.73	4.79	36.90	15.72	184.44	49.76	387.94
Average (6 yrs.)	25.00	136.04	2.59	17.59	5.57	43.03	14.74	173.82	47.90	370.48

Appendix Table 6.—Average runoff and erosion during management periods (6-yr. average, 1963-1968)

Field Description	Residue Management		Seedbed Preparation		Early Growth		Early Growth to Harvest		Total	
	Runoff (ins.)	Soil Loss (T/A)	Runoff (ins.)	Soil Loss (T/A)	Runoff (ins.)	Soil Loss (T/A)	Runoff (ins.)	Soil Loss (T/A)	Runoff (ins.)	Soil Loss (T/A)
0.022-Acre Plots:										
1st. yr. grass	7.46	0.29	0.89	0.58	1.27	1.01	3.04	0.32	12.66	2.20
2nd yr. grass	6.93	1.09	0.57	0.01	0.91	0.02	2.04	0.03	10.45	1.15
Corn after grass	6.26	0.48	0.72	0.53	2.43	4.63	2.39	0.34	11.80	5.98
Rotation average	6.89	0.62	0.73	0.37	1.54	1.88	2.49	0.23	11.65	3.10
Continuous corn,										
up & down hill	6.55	0.49	0.64	0.88	2.54	8.44	2.97	1.14	12.70	10.95
Contour corn	2.28	0.27	0.35	0.06	0.70	0.64	0.83	0.12	4.16	1.09
Bare fallow, loring	13.50	50.45	1.39	4.70	2.09	10.84	5.68	21.76	22.66	87.75
Bare fallow, Lexington	13.15	42.52	1.18	3.31	2.13	8.17	6.36	17.28	22.82	71.28
0.25-Acre Plots (Corn)										
Contoured, graded rows:										
2.50 percent slope	6.10	0.68	0.52	0.96	1.71	1.11	2.79	0.54	11.12	3.29
4.25 percent slope	8.17	0.74	0.65	1.26	1.96	1.94	2.43	0.50	13.21	4.44
10.00 percent slope	10.63	1.29	0.82	3.46	2.11	1.99	3.55	1.04	17.11	7.78

Appendix Table 7.--Annual Runoff (inches)

Water Year	0.022-Acre Plots (5-percent slope)						0.25-Acre, Contoured Graded, Corn Plots				
	1st. year grass	2nd. year grass	corn after grass	rotation average	corn, up and down hill	contour corn	Bare Fallow		2.5- percent slope	4.25- percent slope	10- percent slope
							Loring	Lexington			
1962	*	*	*	*	*	*	*	*	17.64	19.10	24.85
1963	5.86	4.05	4.49	4.80	3.76	0.81	10.32	10.37	3.11	3.97	6.62
1964	10.80	9.23	10.65	10.22	8.24	5.87	27.41	22.30	10.83	12.35	17.18
1965	24.27	19.28	17.89	20.48	20.97	6.67	34.00	34.40	22.26	22.45	28.79
1966	9.08	8.78	8.93	8.93	10.41	5.10	17.56	17.58	8.84	10.42	11.71
1967	14.46	9.91	17.96	14.11	17.17	3.34	22.62	24.99	12.41	14.25	17.59
1968	11.54	11.48	10.90	11.31	15.63	3.17	24.02	27.31	9.21	15.83	20.76
Avg.	12.66	10.45	11.80	11.65	12.70	4.16	22.66	22.82	12.04	14.05	18.21

Appendix Table 8.--Annual Soil Loss (tons per acre)

0.022-Acre Plots (5-percent slope)							0.25-Acre, Contoured, Graded, Corn Plots				
Water Year	1st. year grass	2nd. year grass	corn after grass	rotation average	corn, up and down hill	contour corn	Bare Fallow		2.5- percent slope	4.25- percent slope	10- percent slope
							Loring	Lexington			
1962	*	*	*	*	*	*	*	*	3.98	2.99	7.64
1963	0.78	0.49	0.76	0.68	1.05	0.14	48.94	35.02	0.80	0.77	1.58
1964	0.61	2.09	2.07	1.59	1.63	0.90	98.34	76.09	7.45	9.21	24.43
1965	1.24	3.60	1.70	2.18	2.44	0.70	155.13	135.32	2.71	2.50	3.76
1966	8.80	0.36	8.94	6.02	18.98	2.60	49.26	50.42	3.21	4.95	5.45
1967	1.55	0.15	17.62	6.44	30.94	1.63	92.28	80.07	3.92	6.80	8.30
1968	0.21	0.14	4.77	1.71	10.68	0.61	82.56	50.77	1.65	2.44	3.14
Avg.	2.20	1.15	5.98	3.10	10.95	1.09	87.75	71.28	3.39	4.24	7.76

Appendix Table 9.—Percent of 7-year average annual rainfall, erosion index, runoff, and soil loss four management periods on 0.25-acre corn plots with contoured graded rows

Management Period	Rainfall Percent	EI Percent	2½-Percent Slopes		4¼-Percent Slopes		10-Percent Slopes	
			Runoff Percent	Soil Loss Percent	Runoff Percent	Soil Loss Percent	Runoff Percent	Soil Loss Percent
Residue Management	54.0	38.9	59.8	29.2	66.8	22.5	65.6	23.6
Seedbed Preparation	4.8	4.1	3.7	24.5	4.0	25.5	3.8	38.1
Early Growth	9.6	9.5	12.2	28.0	12.0	39.2	9.9	22.0
Early Growth to Harvest	31.6	47.5	24.2	18.3	17.3	12.8	20.6	16.2







